

## OZONE DESTRUCTION TECHNIQUES

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FIG. 1. OZONE FILTER TEST PROGRAM

- FLIGHT TESTS ON RA001
- SMALL SCALE LAB TESTS
  - FILTER MATERIALS SURVEY
  - ACCELERATED LIFE TESTS
- FULL SCALE LAB TESTS
  - DESIGN VERIFICATION TESTS
  - FLAME
  - VIBRATION
  - ACCELERATED CONTAMINATION
  - LIFE CYCLE
  - CABIN AIR QUALITY

FIG. 2. OZONE INSTRUMENTATION

### Lab Test Ozone Monitors

- Ultra-Violet Adsorption Type
  - Dasibi Corp. Model 1003
- Chemiluminescent Type
  - Columbia Scientific Ind. (CSI Model 2000)
  - Analytical Instrument Development, Inc. (AID Model 560)

FIG. 3. OZONE ANALYZER SCHEMATIC - ULTRA-VIOLET LIGHT ADSORPTION TYPE

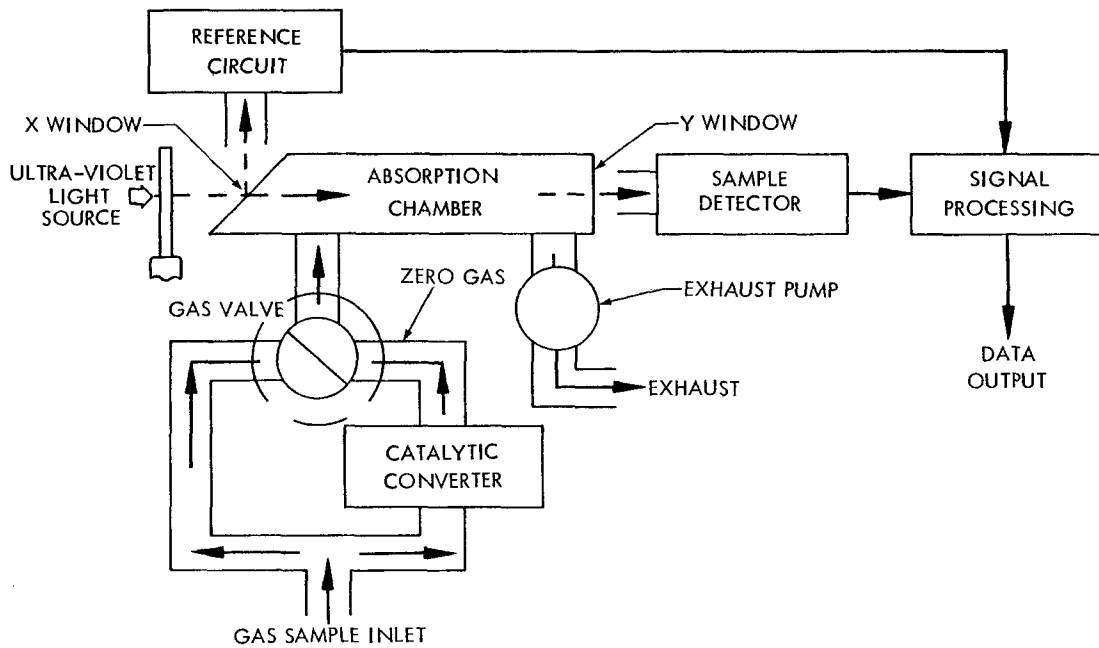


FIG. 4. OZONE ANALYZER SCHEMATIC - CHEMILUMINESCENT TYPE

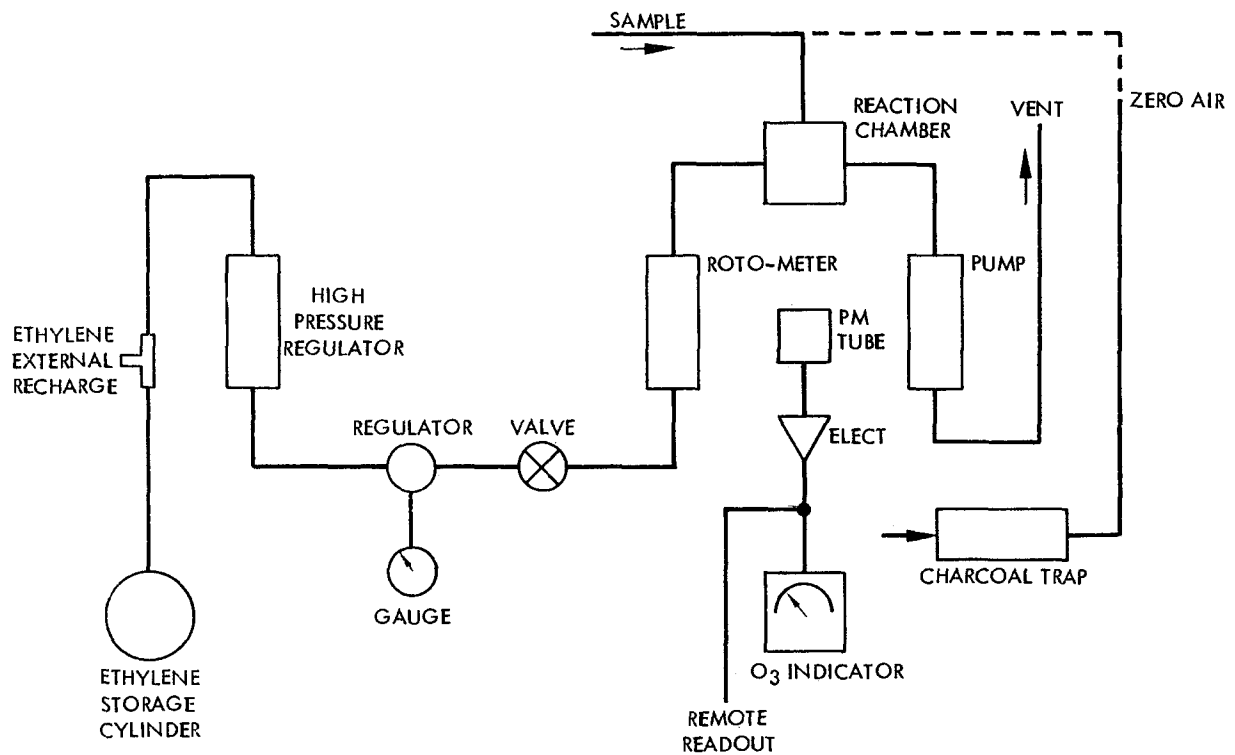


FIG. 5. SMALL SCALE OZONE FILTER TEST SETUP

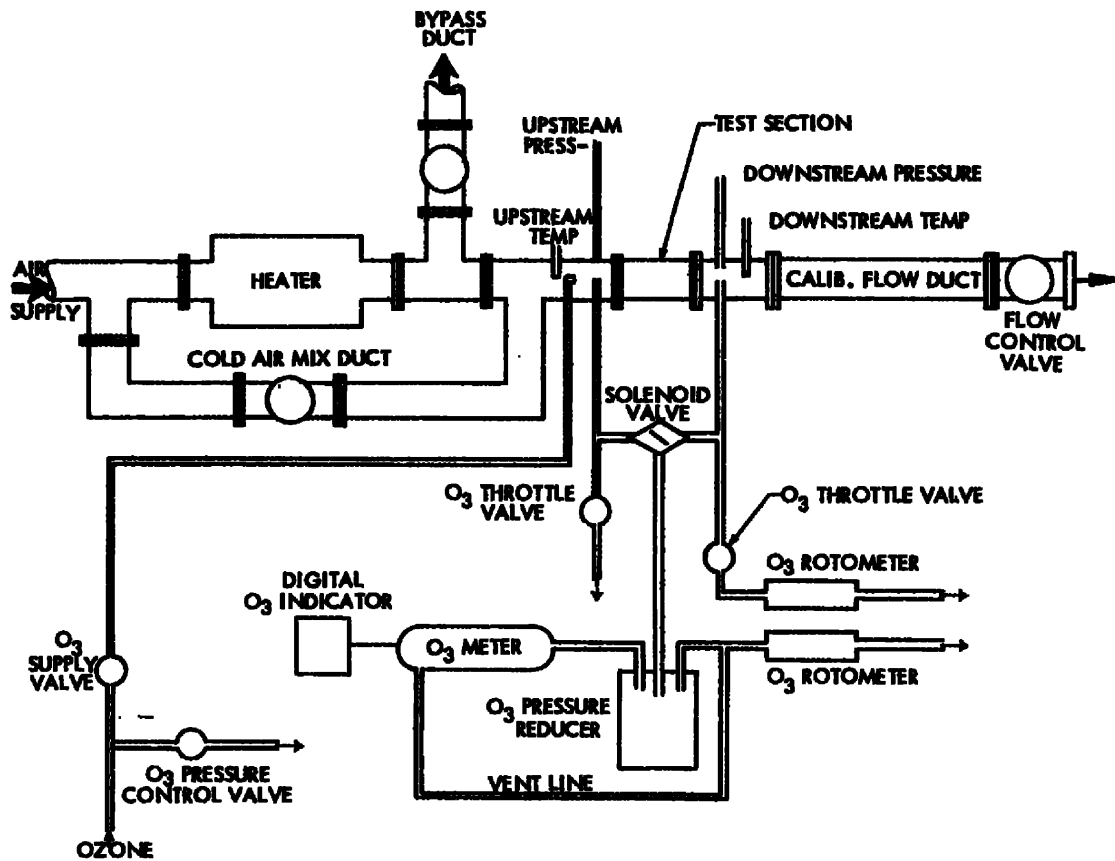
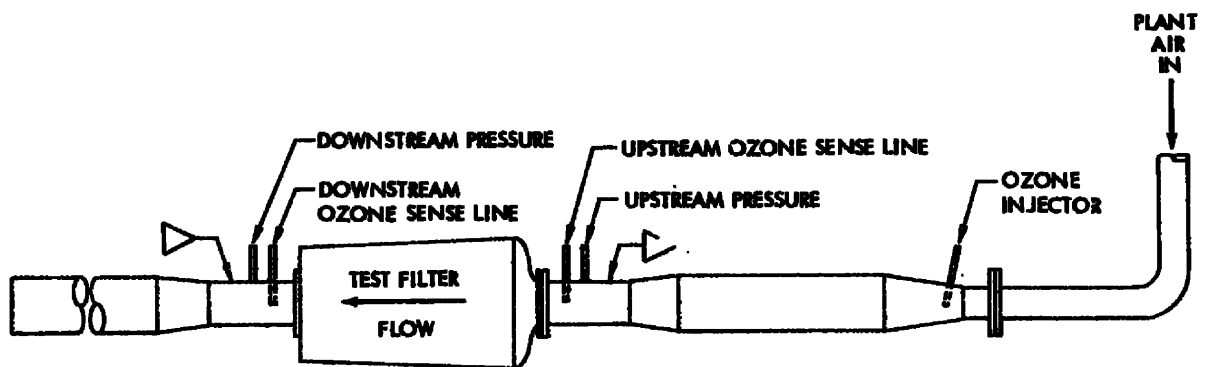


FIG. 6. FULL SCALE PRODUCTION FILTER FUNCTIONAL LAB TEST - TEST SETUP SCHEMATIC



▷ UPSTREAM & DOWNSTREAM TRANSITION SAME DIAMETER AS FILTER BEING TESTED

FIG. 7. PNEUMATIC DUCT - LAB TEST PHOTOS

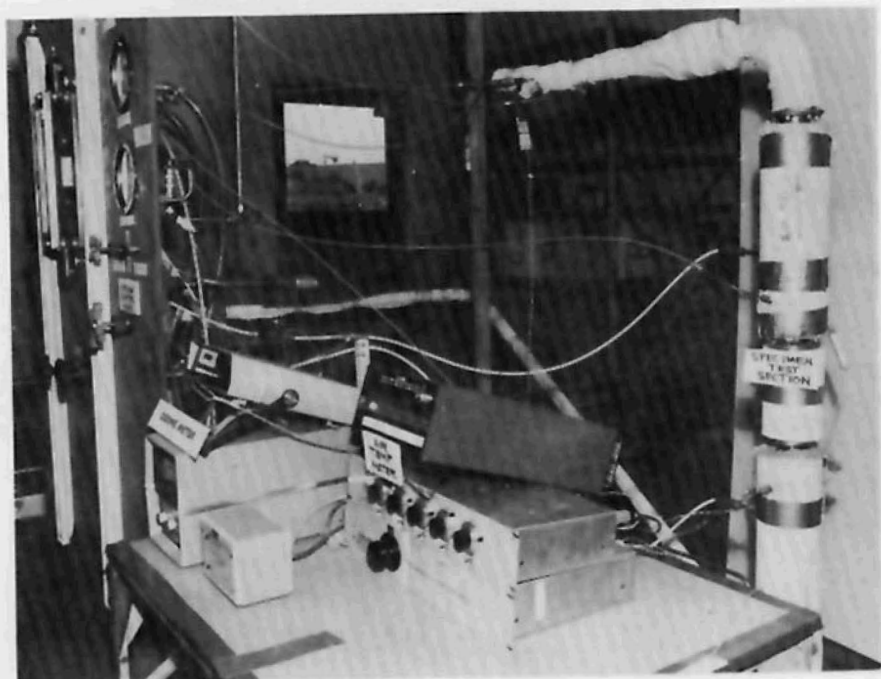


FIG. 8. FULL SCALE LAB TEST PHOTOS

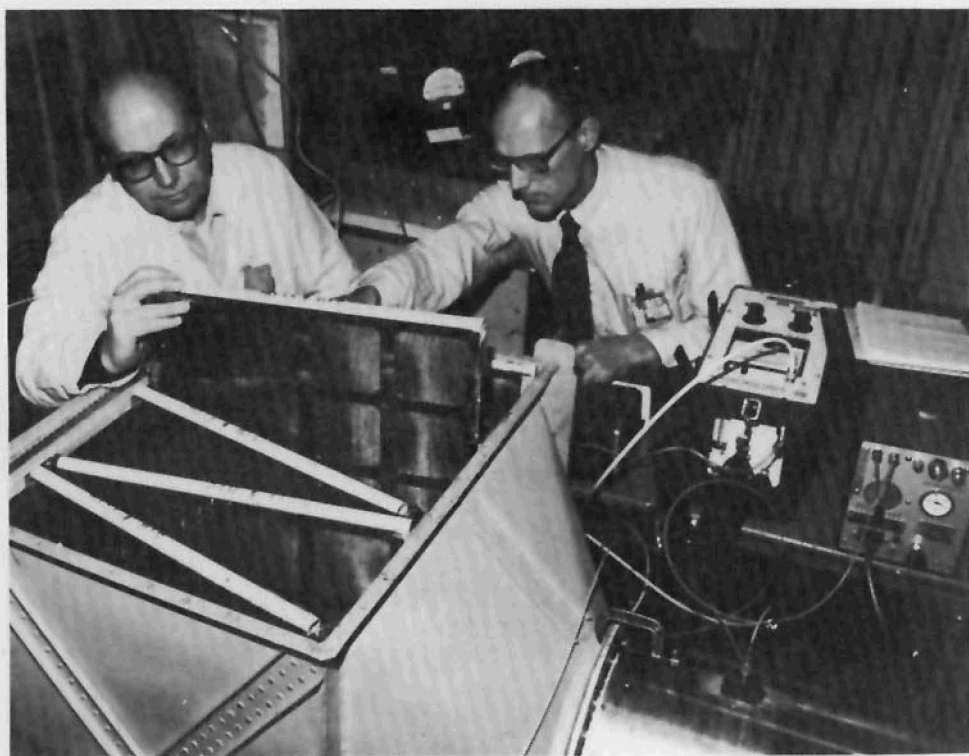
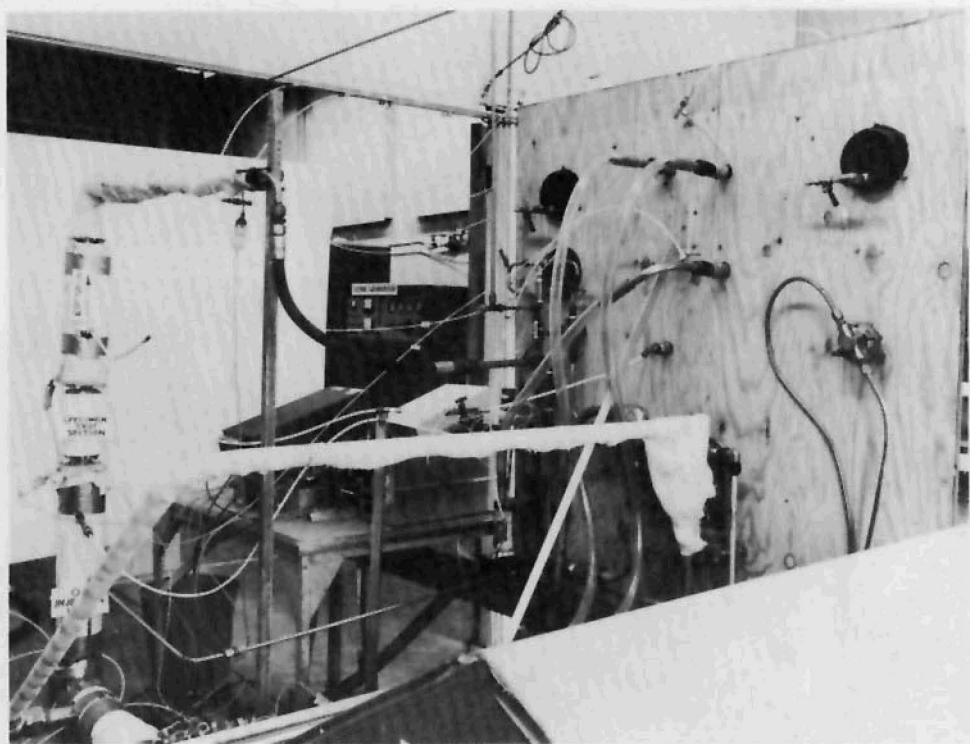


FIG. 9. FULL SCALE LAB TESTS

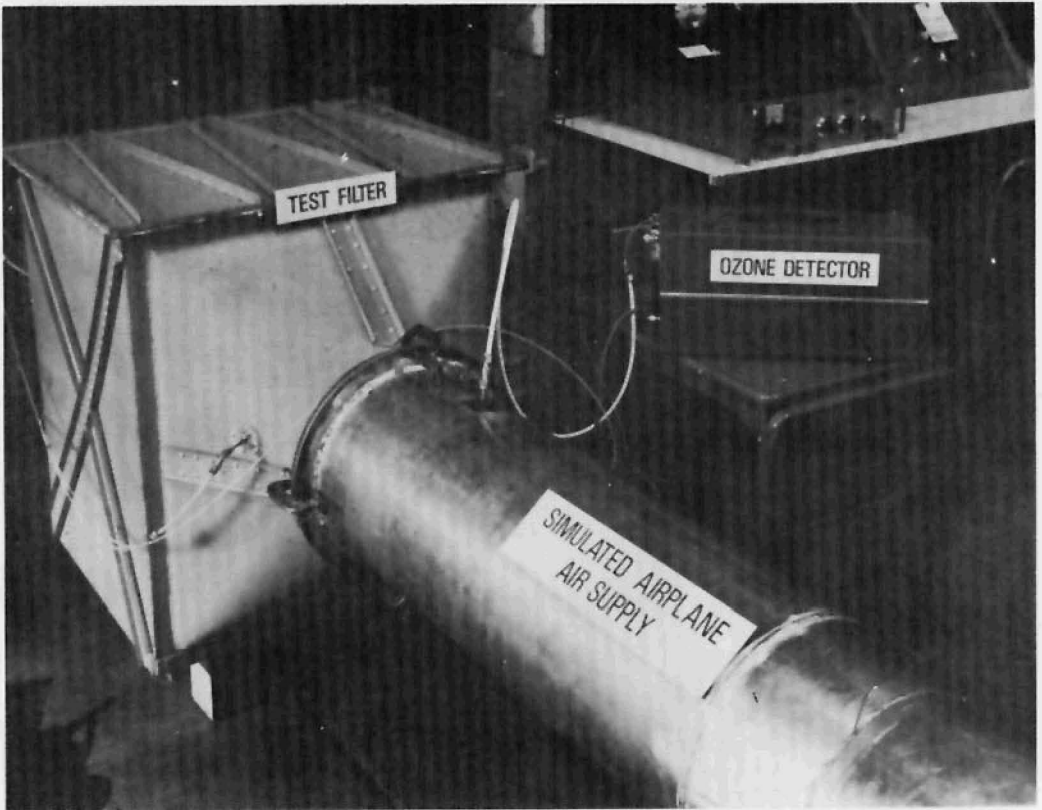


FIG. 10. CABIN ADSORPTION FILTER MATERIALS

TESTED

● CHARCOAL

BARNEY CHENEY TYPE AC

\* BARNEY CHENEY TYPE 848

WHITCO 955

NORTH AMERICAN G 210

NORTH AMERICAN G 212

UNION CARBIDE JXC

WESTAVACO NUCHAR

● HOPCALITE & HOPCALITE/ CLOTH

● AMBERSORB

● ZEOLITES 4A, 5A, 7/8 13X

● SILVASAN (PURALOTOR)

● ULTRA-VIOLET

● MSA HOPCALITE FILTER PANEL

● ENGELHARD CATALYST P/N A-18673

\* Presently In Use

FIG. 11. SMALL SCALE LAB TEST RESULTS - CHARCOAL

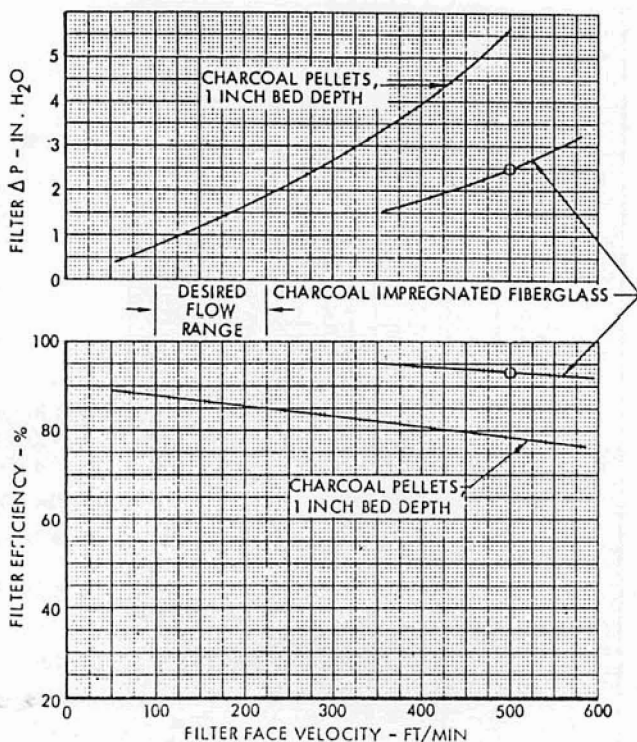


FIG. 12. FULL SCALE LAB TEST RESULTS - CHARCOAL FILTERS (ZONES 2 AND 3)

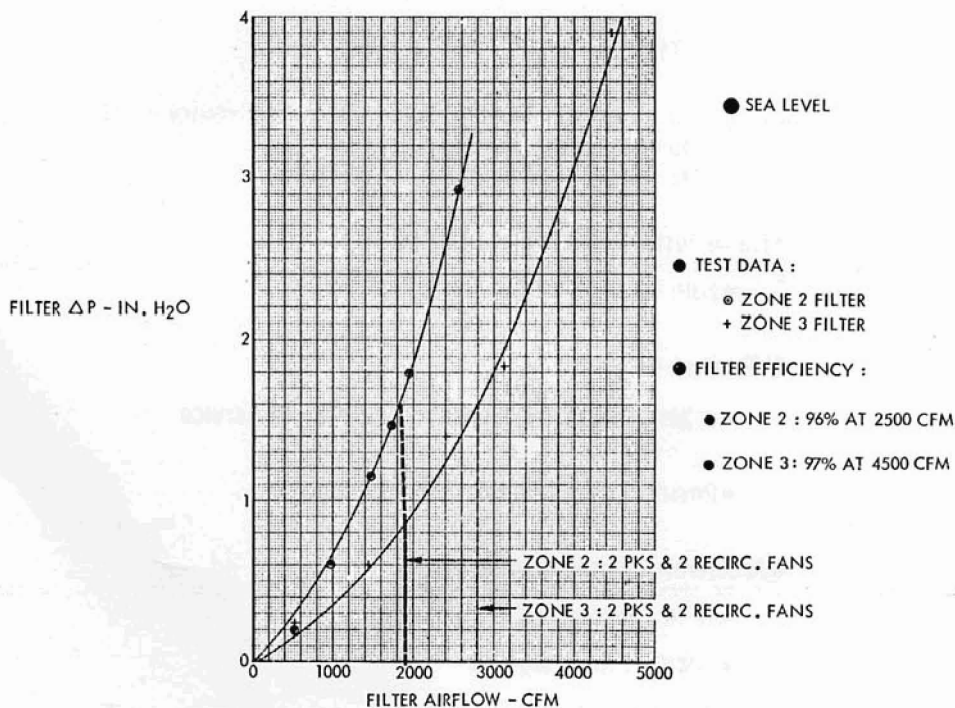


FIG. 13. FULL SCALE LAB TEST RESULTS - CHARCOAL FILTERS (ZONES 1 AND 4)

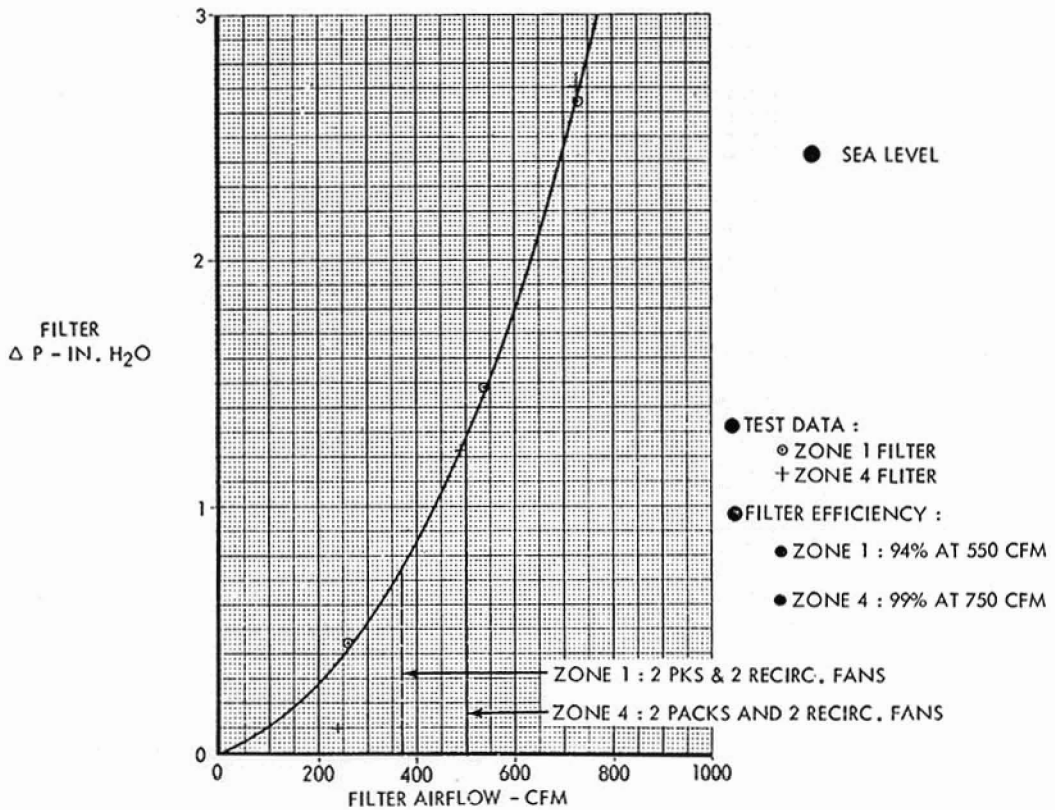


FIG. 14. DESIGN VERIFICATION TESTS

**Objective:** To Show Compliance With Certification Requirements  
 To Give Confidence For Safety  
 To Indicate Effectivity Vs. Time Effect

- Flame Tests (Certification Requirement)
  - Both 12 Sec & 60 Sec Flame Test Passed
- Vibration Tests
  - 0.24% Wt Loss In Simulated One Year Of Service
  - Result - Much Better Than Anticipated
- Accelerated Contamination Tests
  - 72 Hr. Ozone Test
  - JP4/O<sub>3</sub>/Time/Temp Test
  - Simulated Service Cycle Test



FIG. 15. OZONE FILTER EFFICIENCY VS TIME - LAB TEST OF RA001 FILTER

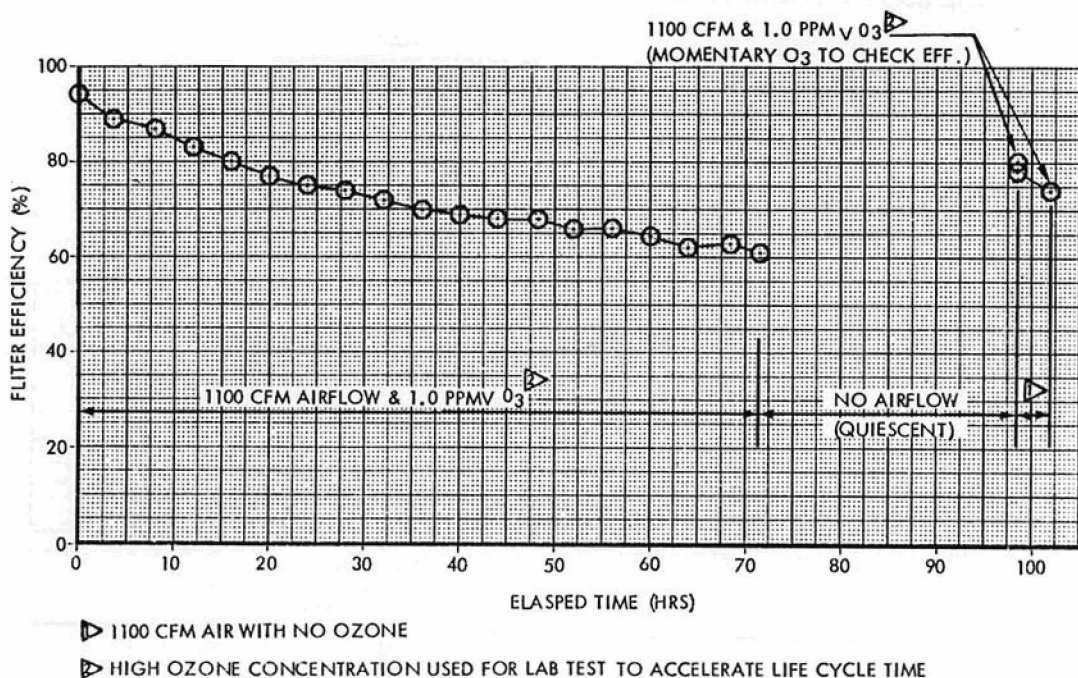


FIG. 16. FULL SCALE LAB TEST RESULTS - RA001 FILTER CONTAMINATION CYCLE TEST - 1 INCH CHARCOAL BED

TEST CYCLE

- (1) INJECT 10. CC OF JP-4
- (2) OZONE INJECTED @ 1.0 PPMV @ 2,200 CFM ▷
- (3) HOT AIR CLEAN AT 200°F
- (4) NO HOT AIR CLEAN - 3 HR REST ONLY

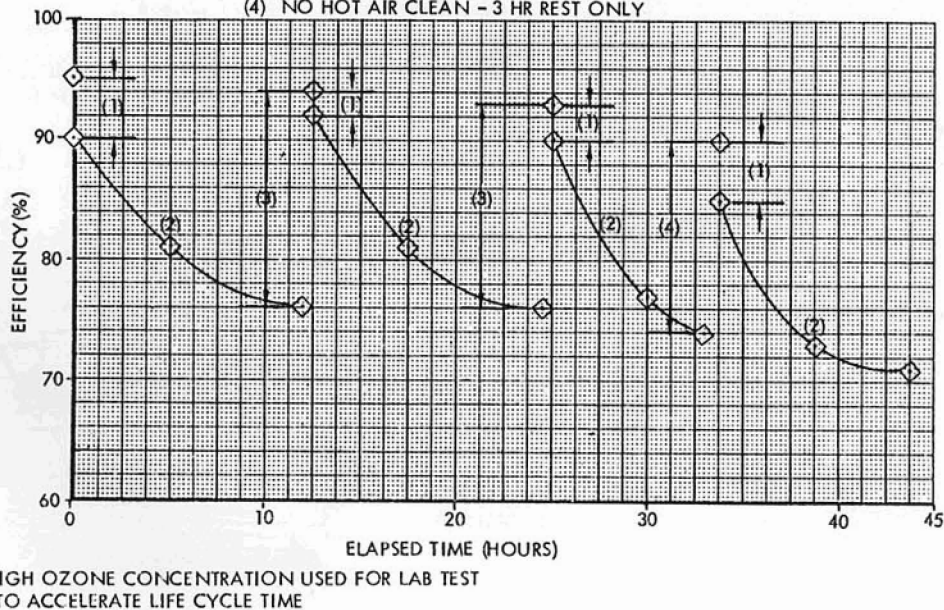


FIG. 17. ZONE 2 FILTER LIFE CYCLE TEST USING BARNEBY CHENEY TYPE A/C CHARCOAL

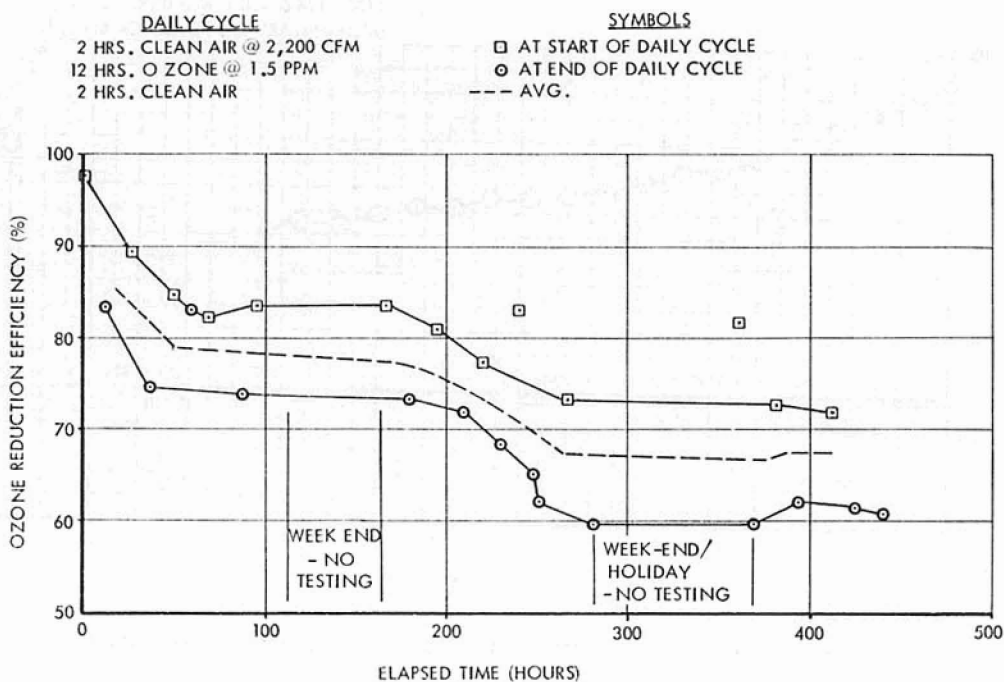


FIG. 18. CONDITIONED AIR FILTER INSTALLATION

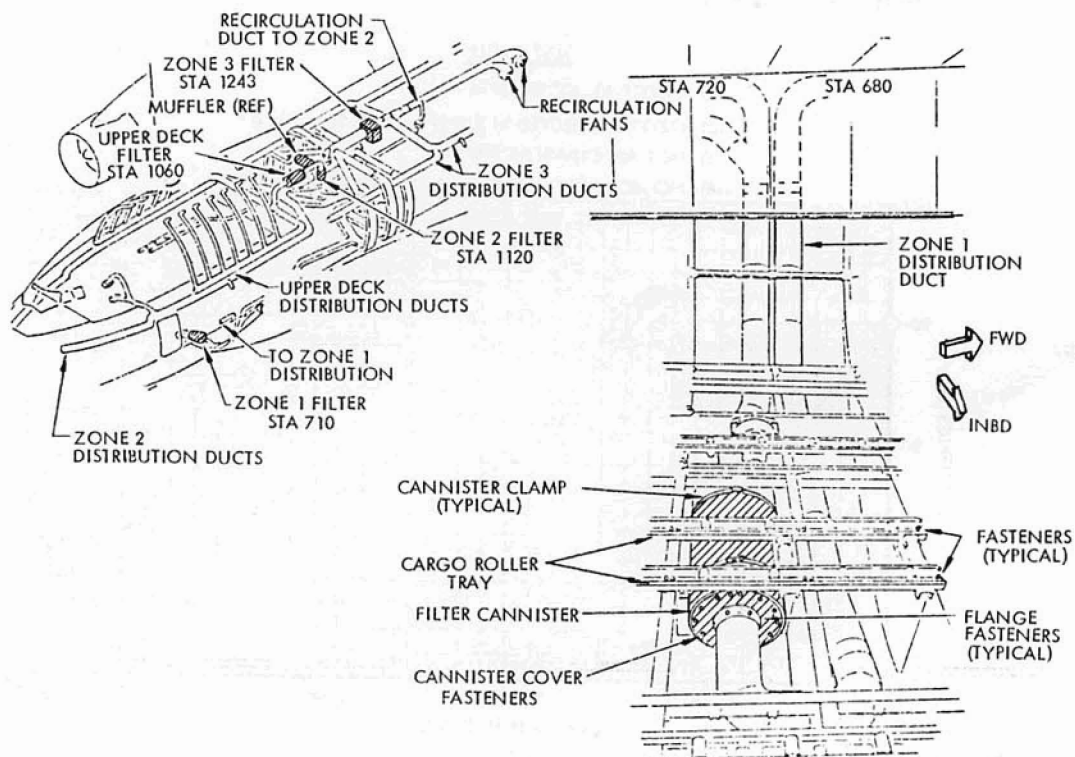


FIG. 19. CONDITIONED AIR FILTER INSTALLATION

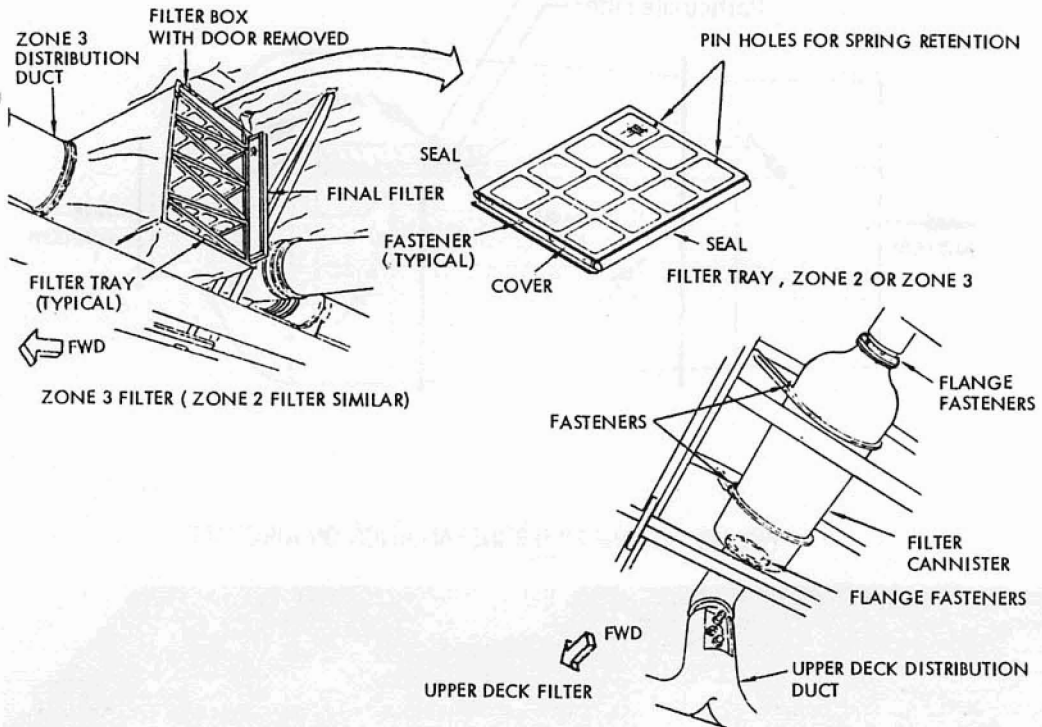


FIG. 20. OZONE FILTER

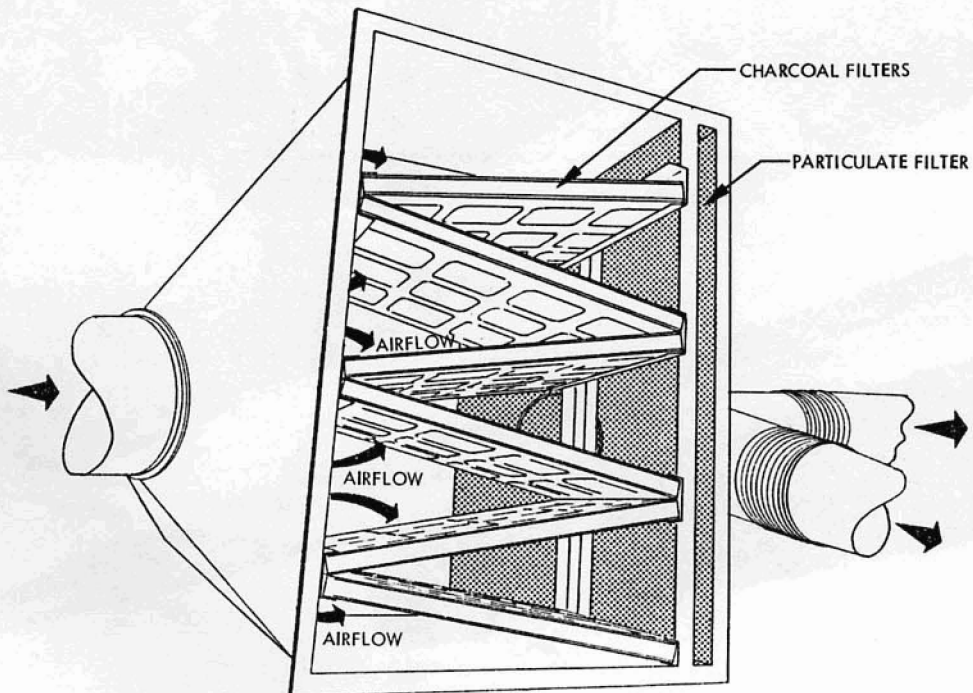


FIG. 21. CHARCOAL FILTER CANISTER TYPE - ZONES 1 AND 4

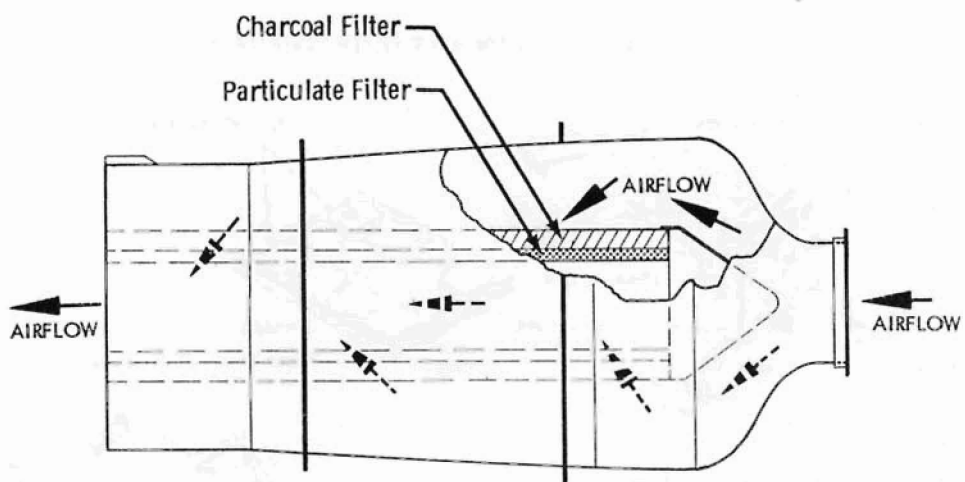


FIG. 22. OZONE FILTER INSTALLATION ON AIRCRAFT

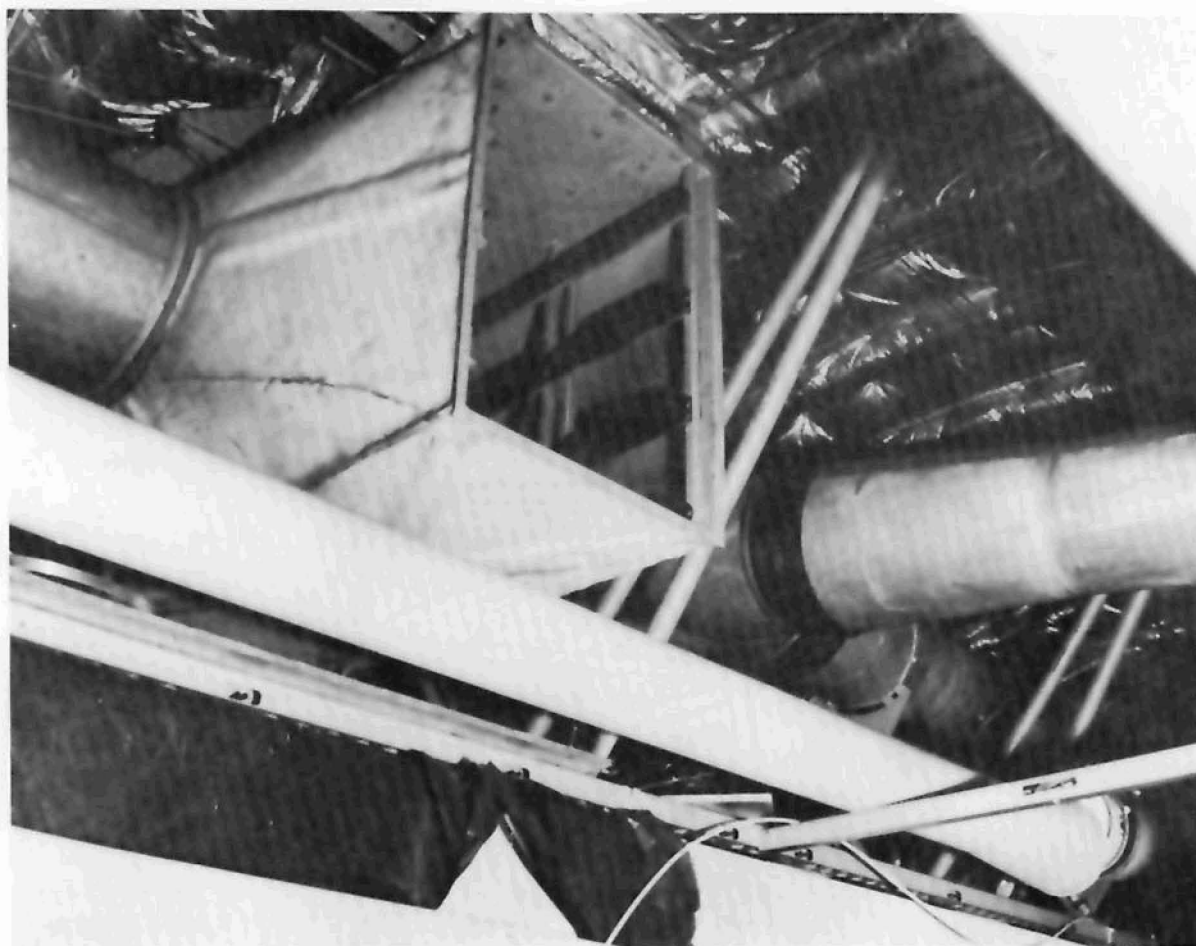


FIG. 22. CONTINUED.

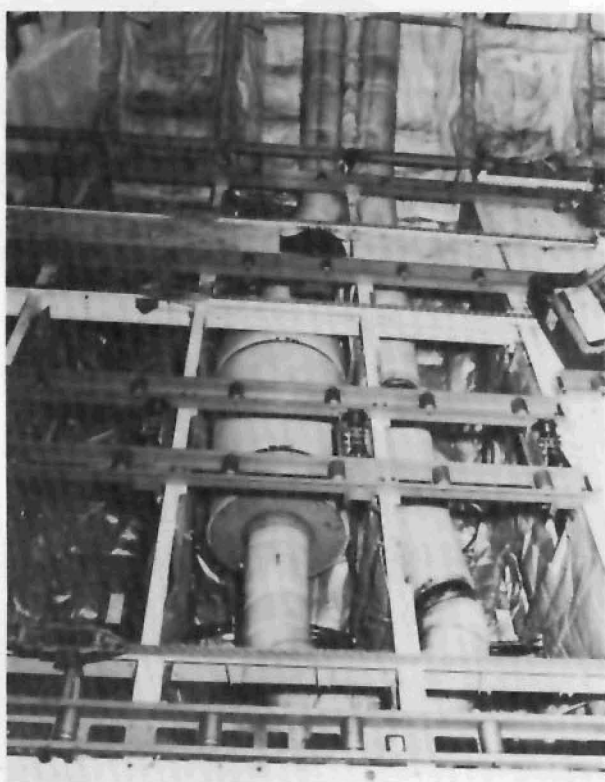
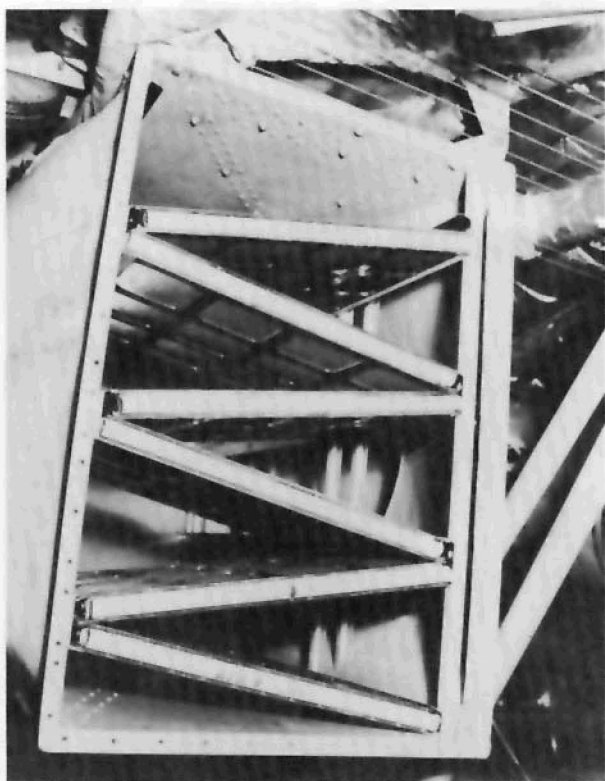


FIG. 22. CONCLUDED.

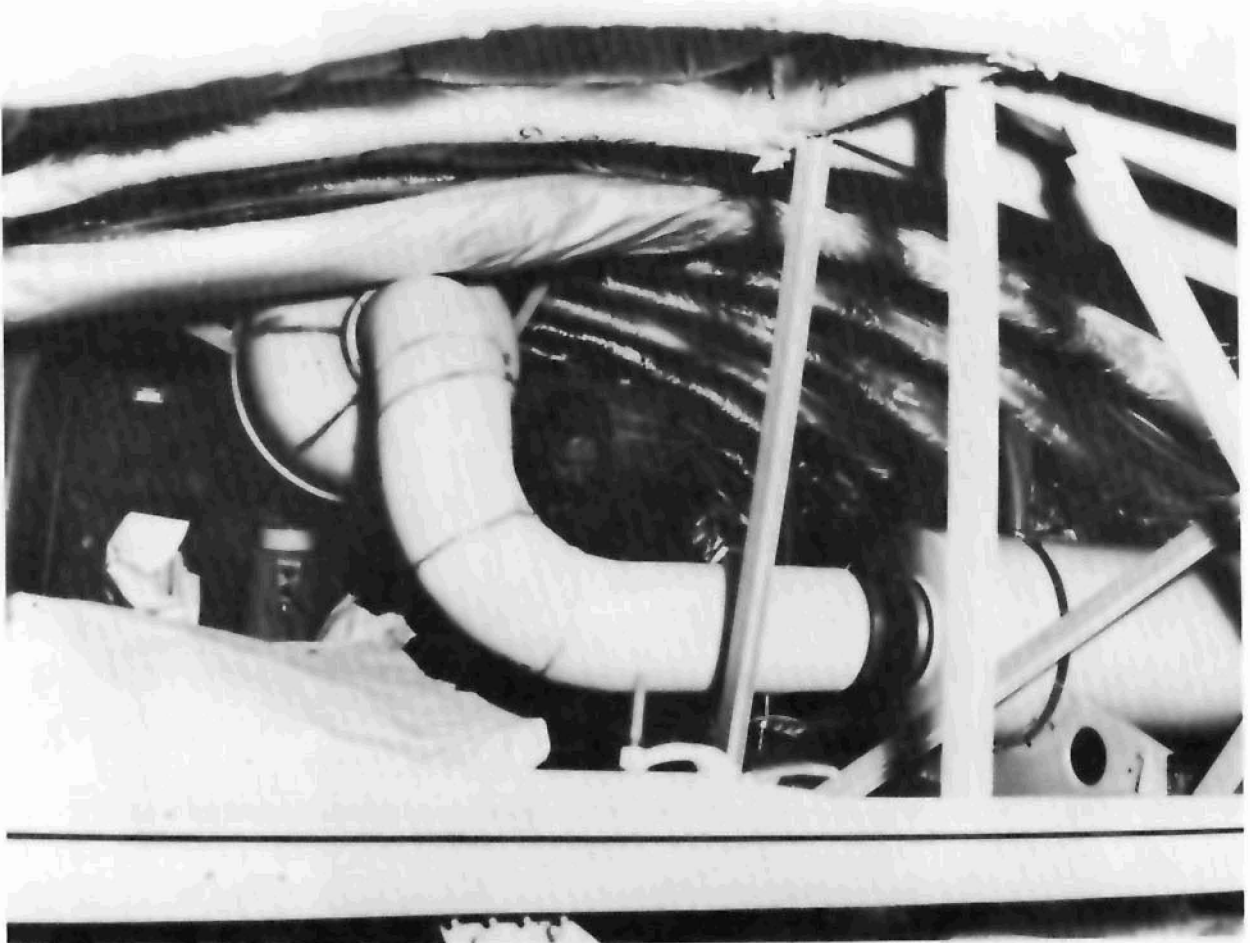


FIG. 23. ADDITIONAL CABIN FILTER LAB TESTS

- CHARCOAL SURVEY TESTS - SMALL SCALE
- PAA SERVICE FILTER LAB TESTS
- MSA PLEATED HOPCALITE MATERIAL
- ENGLEHARD CATALYST P/N A - 18673

FIG. 24. FILTER EFFICIENCY VS FILTER FACE VELOCITY - 1/2" CHARCOAL FILTERS

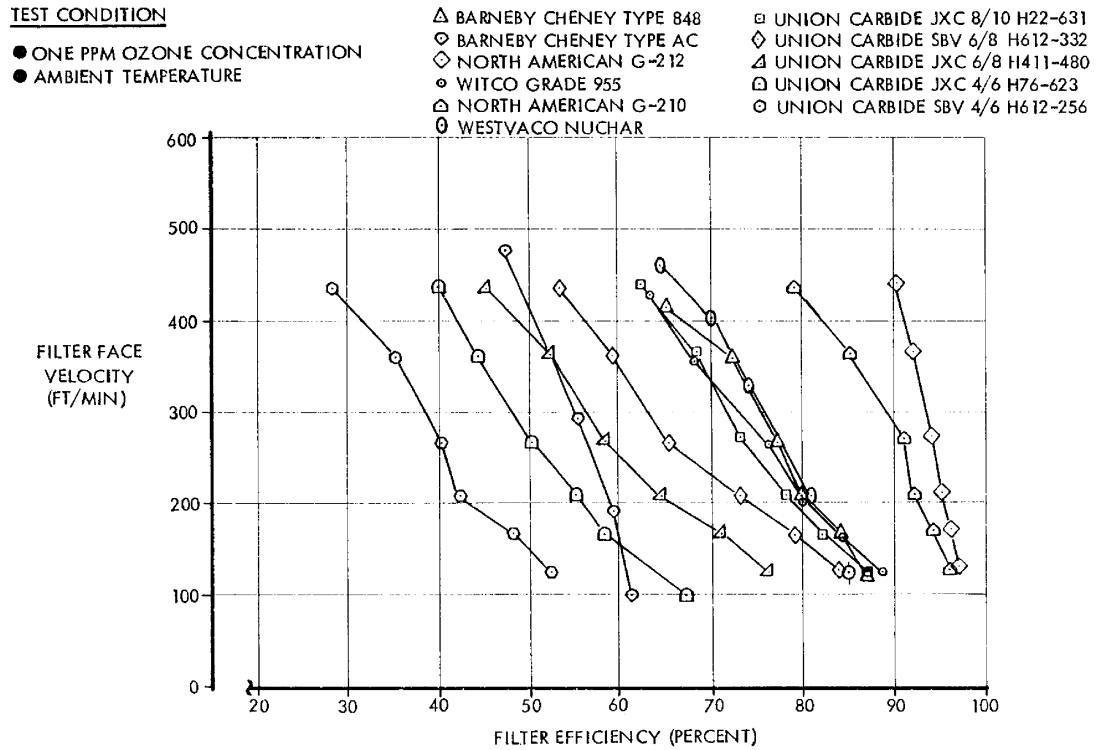


FIG. 25. PAA CHARCOAL FILTER EFFICIENCIES AS DETERMINED FROM LAB TEST DATA

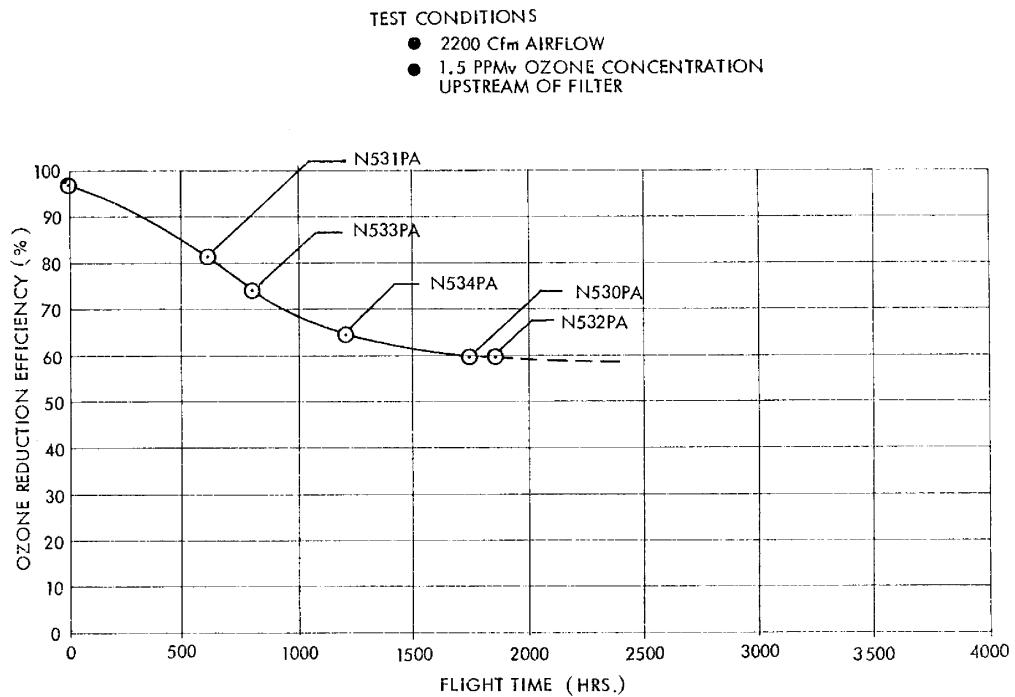


FIG. 26. MSA PLEATED HOPCALITE FILTER PANEL - LIFE CYCLE TESTING

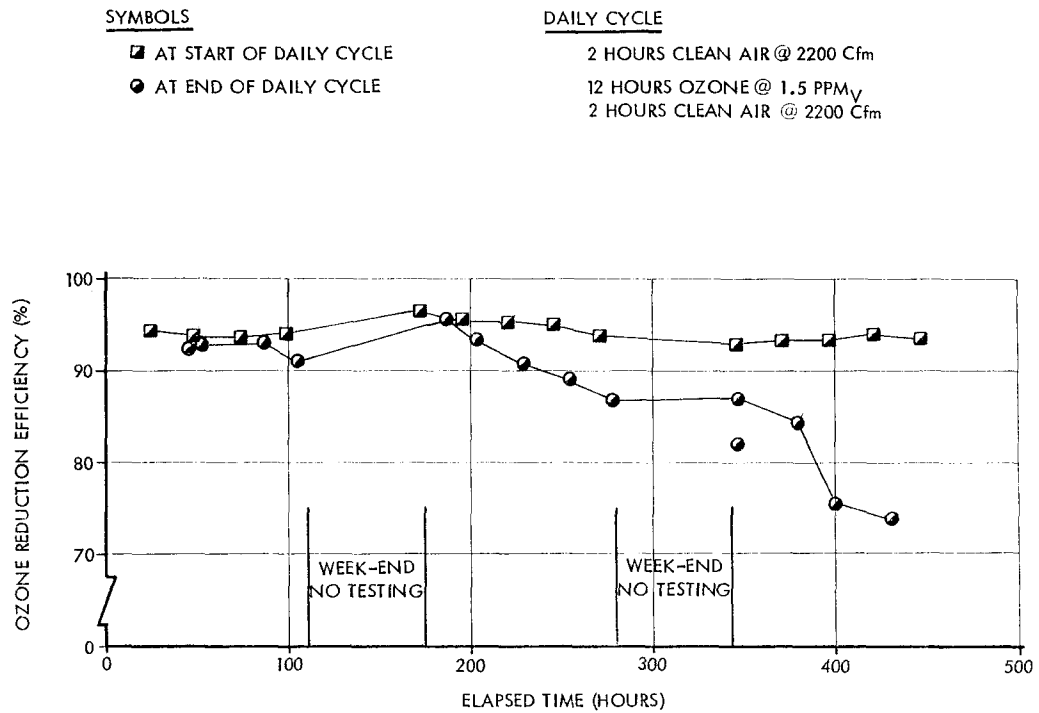


FIG. 27. MSA PLEATED HOPCALITE FILTER PANEL - FILTER EFFICIENCY VS. OZONE LEVEL

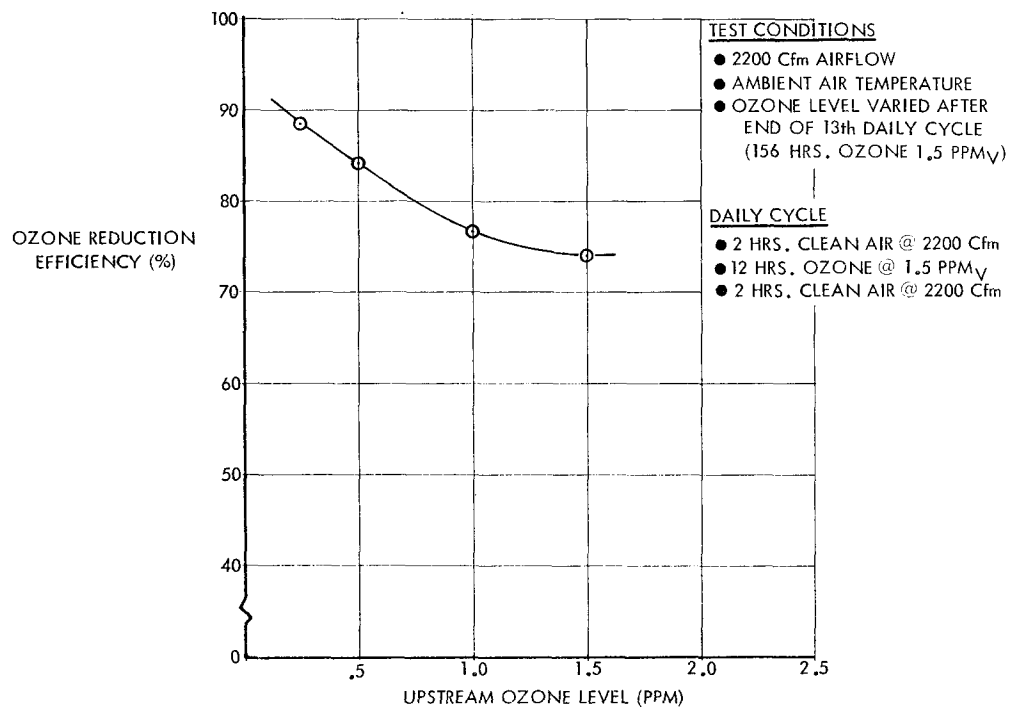




FIG. 28. FILTER EFFICIENCY VS FILTER FACE VELOCITY 1/2" THICK FILTERS

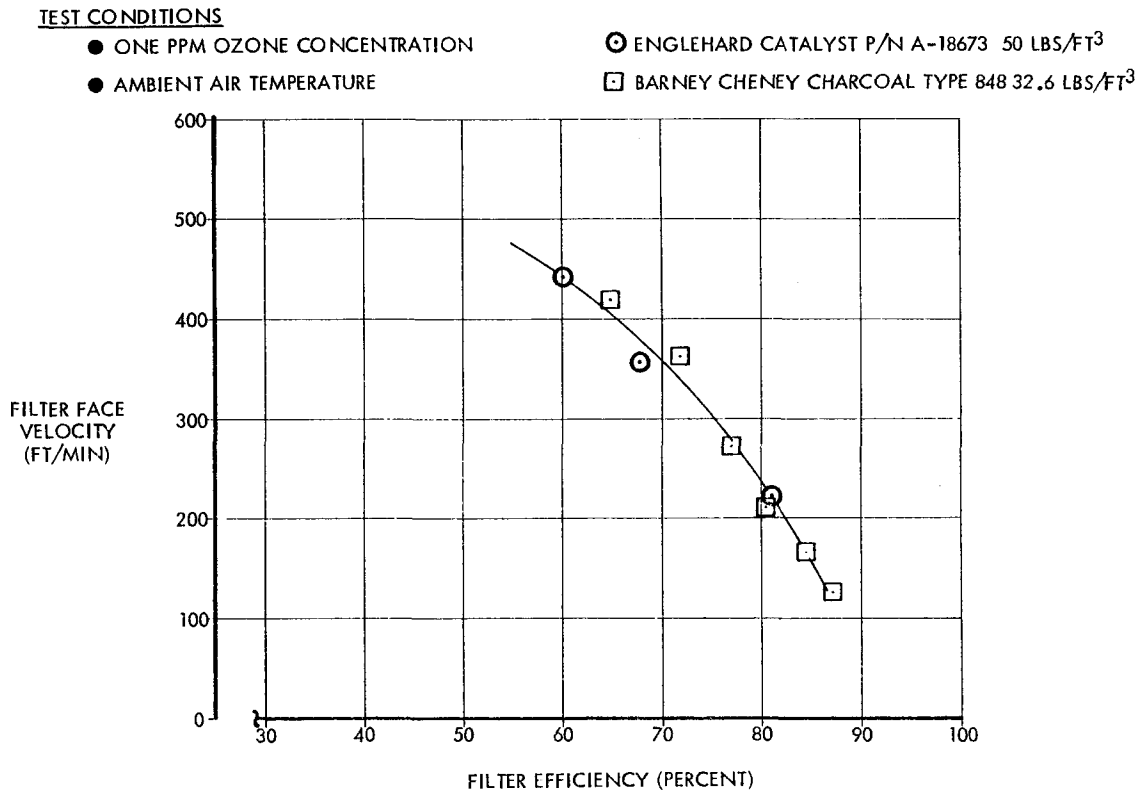


FIG. 29. PNEUMATIC DUCT (CATALYTIC MATERIALS)

TESTED

MSA Hopcalite	Engelhard Catalyst
Nickel Screens	<ul style="list-style-type: none"> <li>• Spheres</li> <li>• Cylinders</li> </ul>
Nickel Wool	DEOXO
Brass Wool	• Pellets P/N A-18673
Zeolites 4A, 5A, & 13X	• Raremetal On Tubes And Ceramic Honeycomb
Purolator Silvasan Cert 361	3M Company Honeycomb Filter
United Oil Products Catalysts	Palladium (Rare Metal) Spheres
<ul style="list-style-type: none"> <li>• No. 3443-120-25</li> <li>• No. P3-3008</li> <li>• Honeycomb Filter</li> </ul>	Emery Ceramic Honeycomb Filter
Alumina & Alumina/Silver Oxide	Dart Ind. Sintered Metal Filter
Alumina/Cu O	
Alumina/Mn O <sub>2</sub>	

FIG. 30. PNEUMATIC MANIFOLD CATALYTIC FILTER LOCATIONS

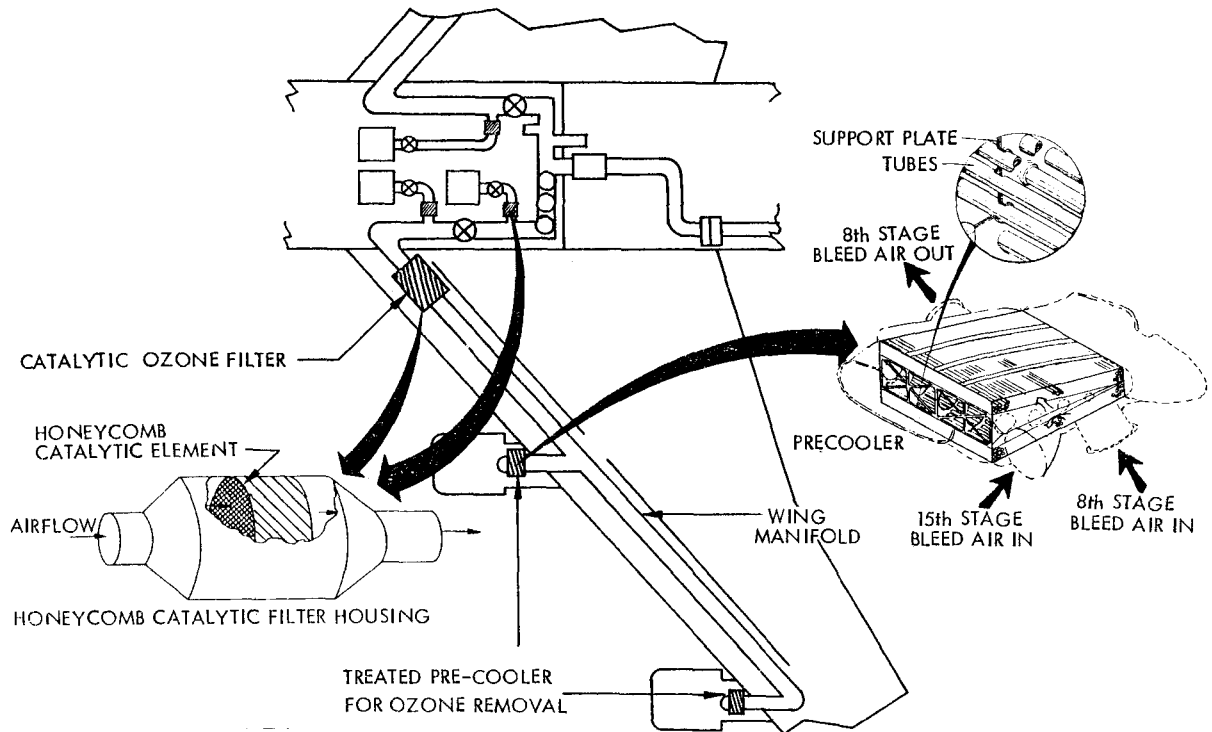


FIG. 31. FULL SCALE PNEUMATIC DUCT FILTER LAB TEST - TEST SETUP SCHEMATIC

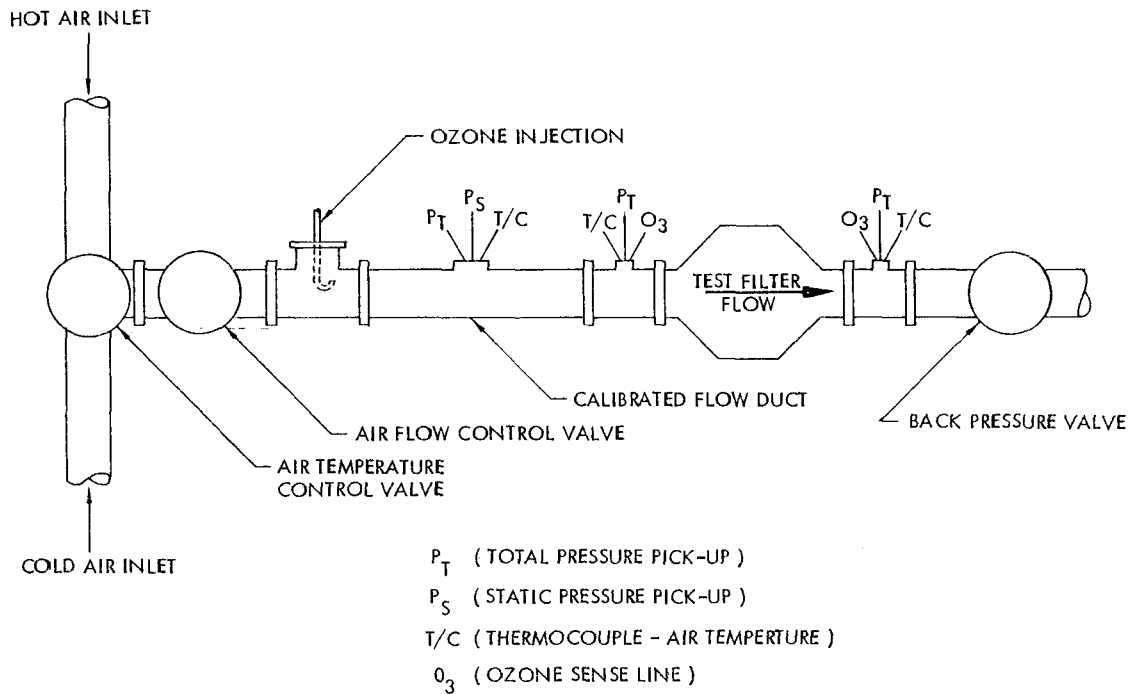


FIG. 32. FULL SCALE PNEUMATIC DUCT FILTER OZONE MEASUREMENTS SCHEMATIC

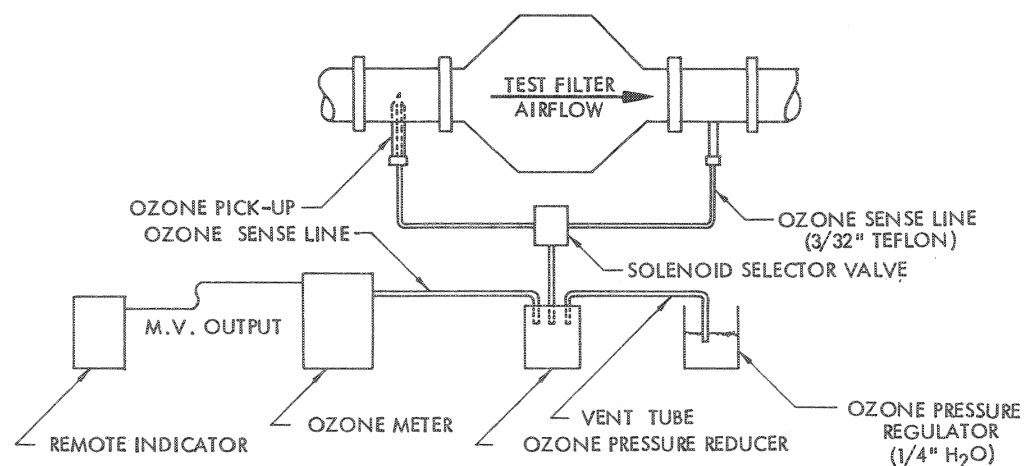


FIG. 33. PNEUMATIC DUCT FILTER - LAB TEST SETUP

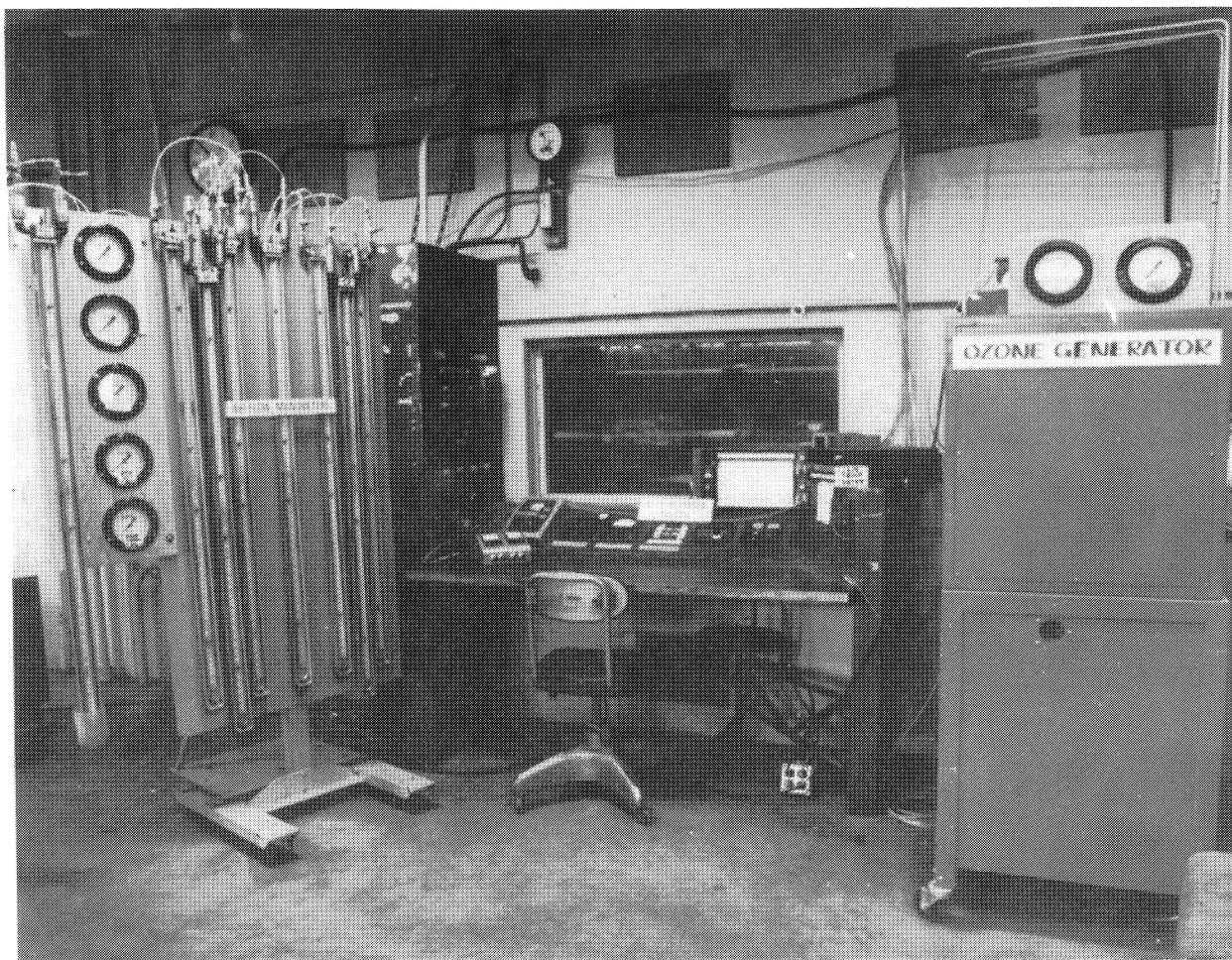


FIG. 33. CONCLUDED.

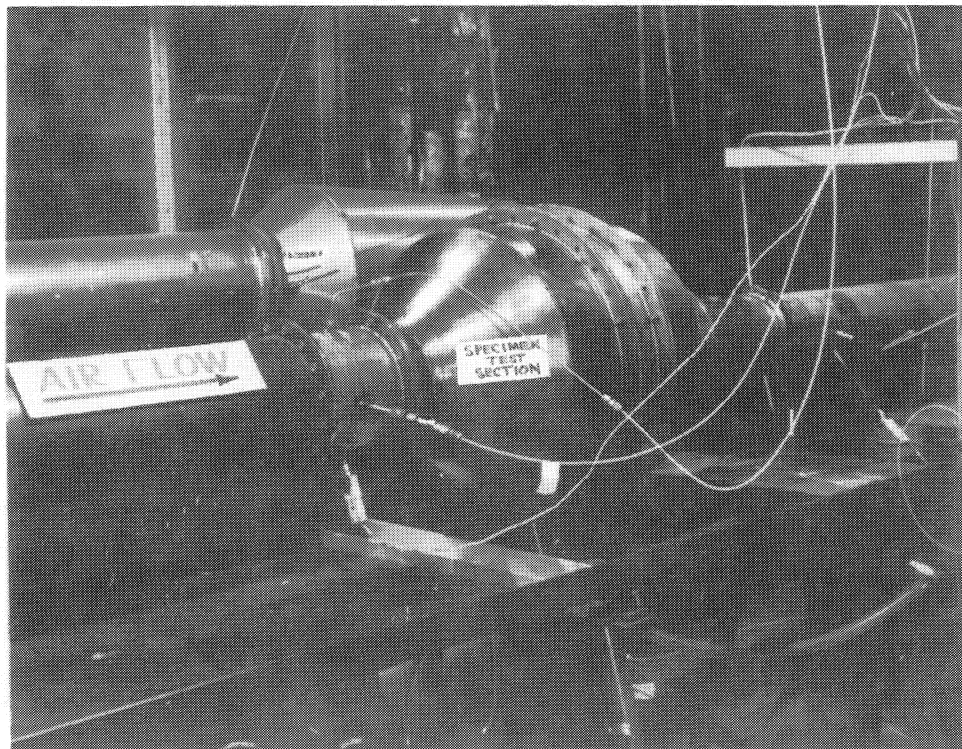
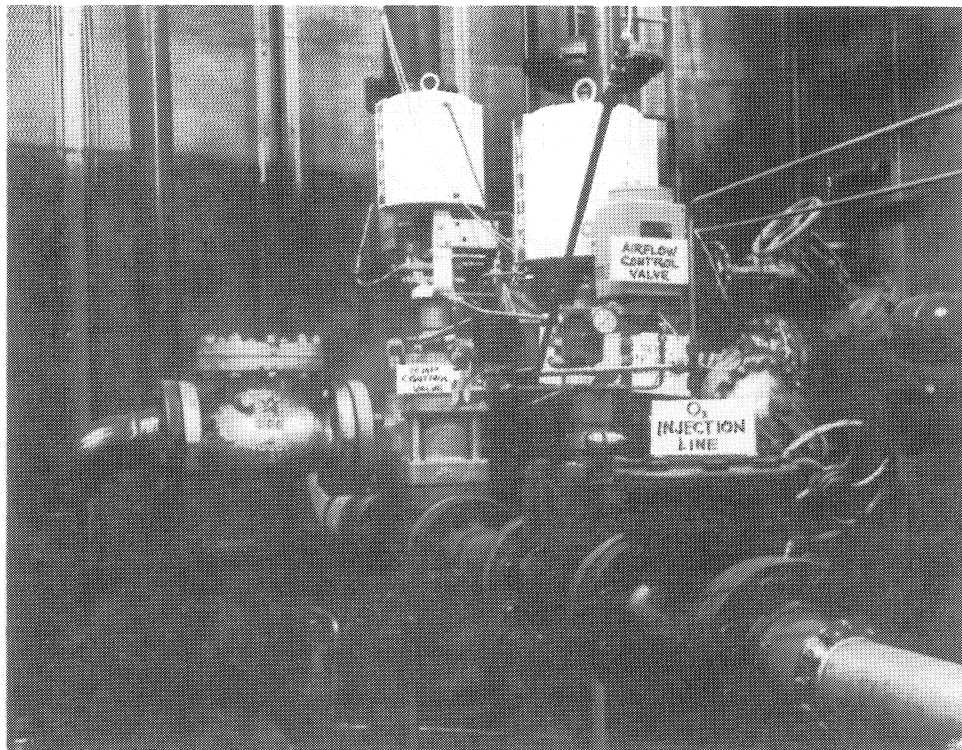


FIG. 34. OZONE MEASUREMENTS SETUP

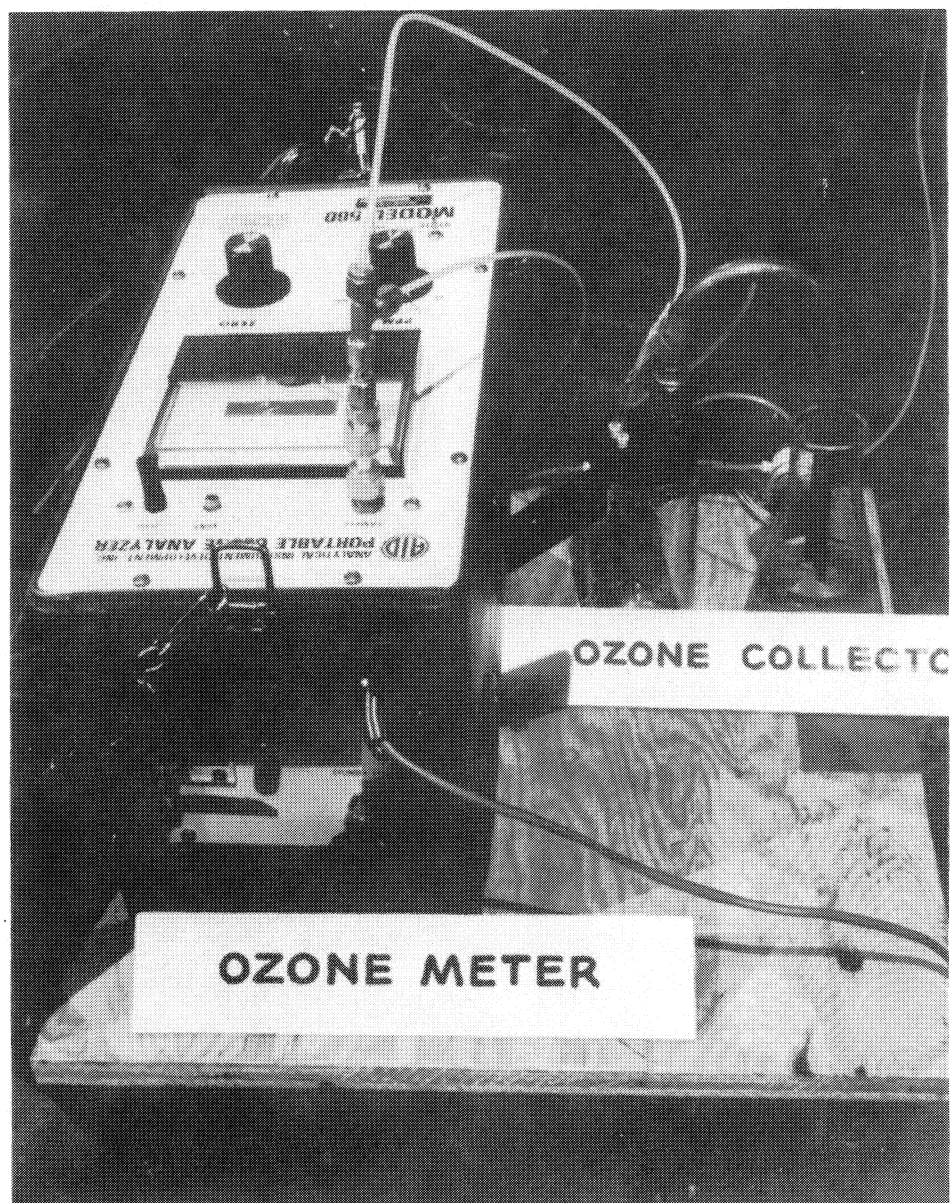


FIG. 35. LAB TEST RESULTS

- ENGLEHARD CATALYST
- HOPCALITE
- HONEYCOMB CATALYST
- DART SINTERED METAL

FIG. 36. ENGLEHARD CATALYST PIN A-1867 FILTER PERFORMANCE - SMALL SCALE TEST RESULTS

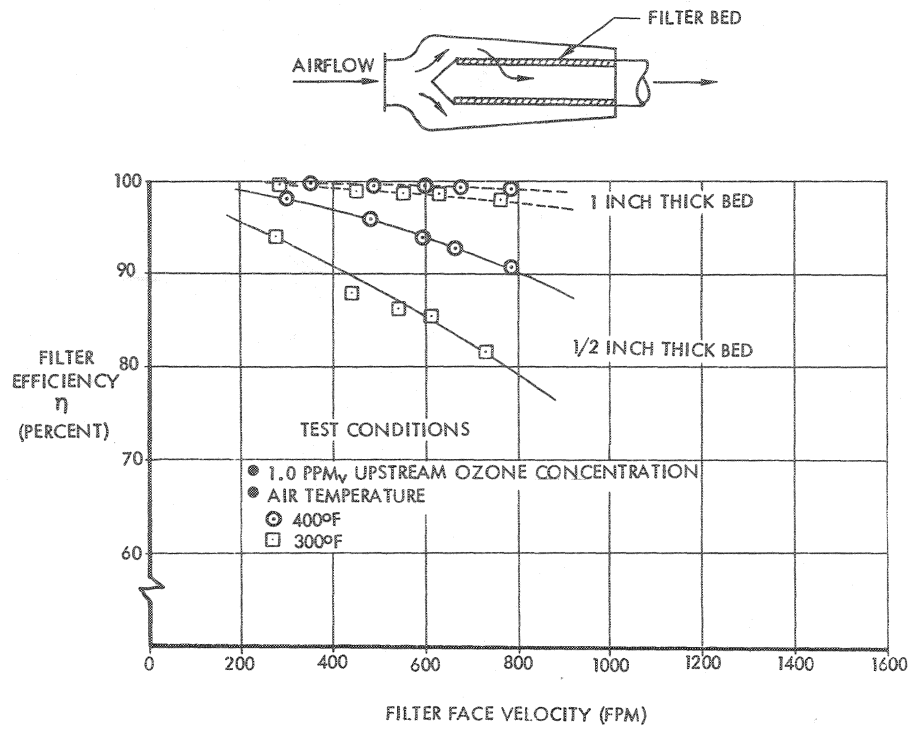


FIG. 37. HOPCALITE OZONE FILTER PERFORMANCE - SMALL SCALE TEST RESULTS

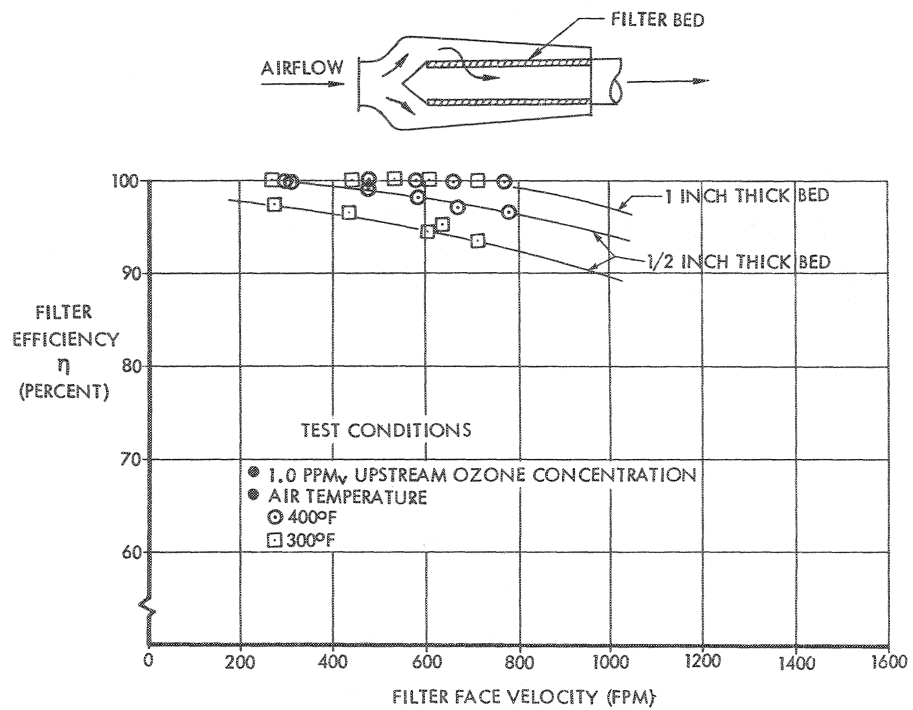




FIG. 38. HONEYCOMB CATALYTIC OZONE FILTER PERFORMANCE - FULL SCALE TEST RESULTS

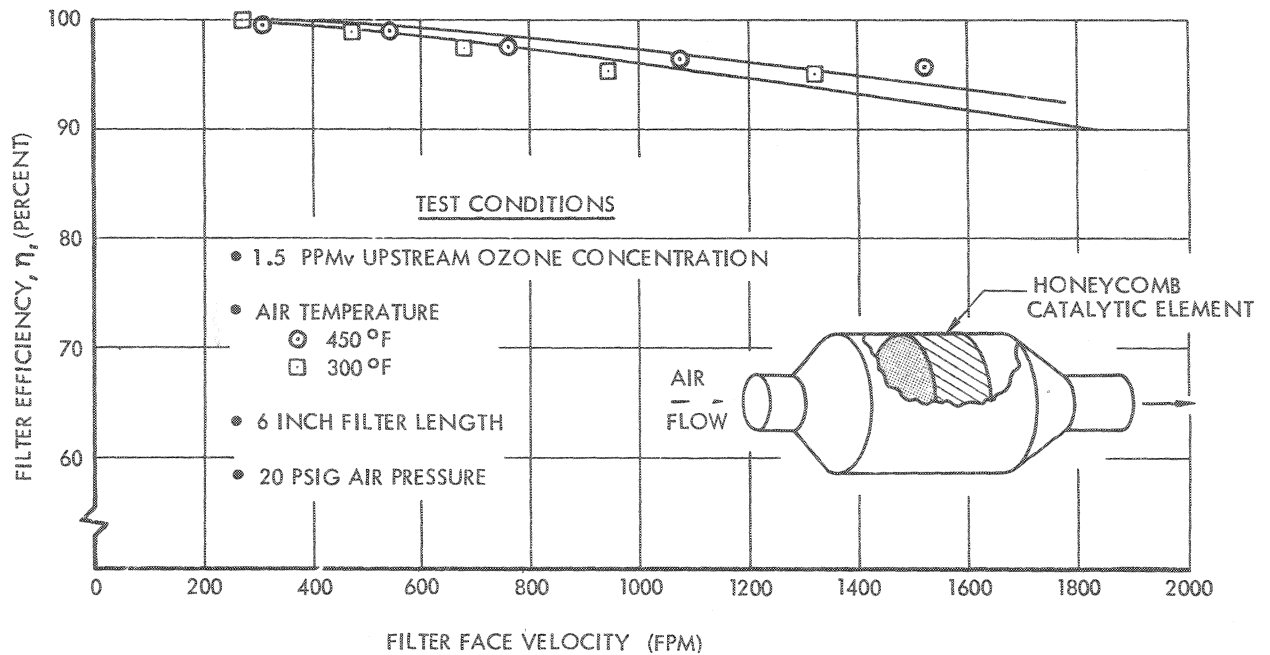


FIG. 39. DART SINTERED METAL OZONE FILTER PERFORMANCE - FULL SCALE TEST RESULTS

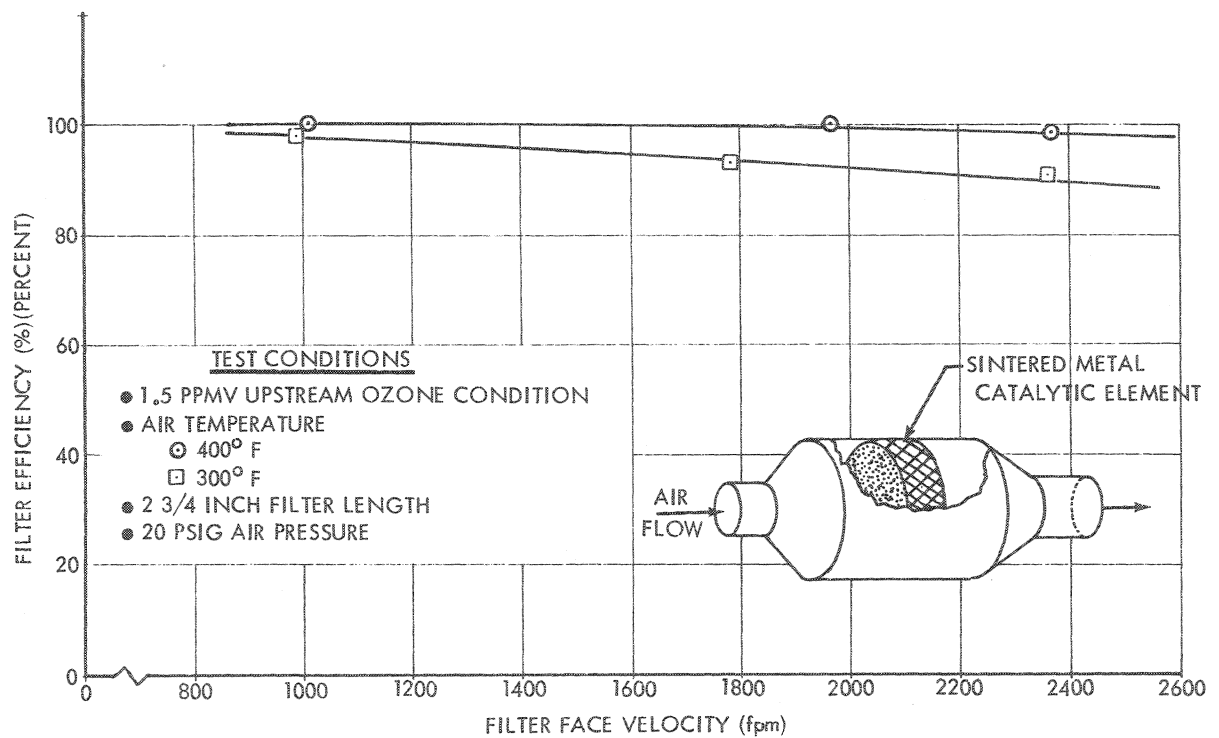


FIG. 40. HONEYCOMB CATALYTIC FILTER EFFICIENCY VS BED CONTACT TIME

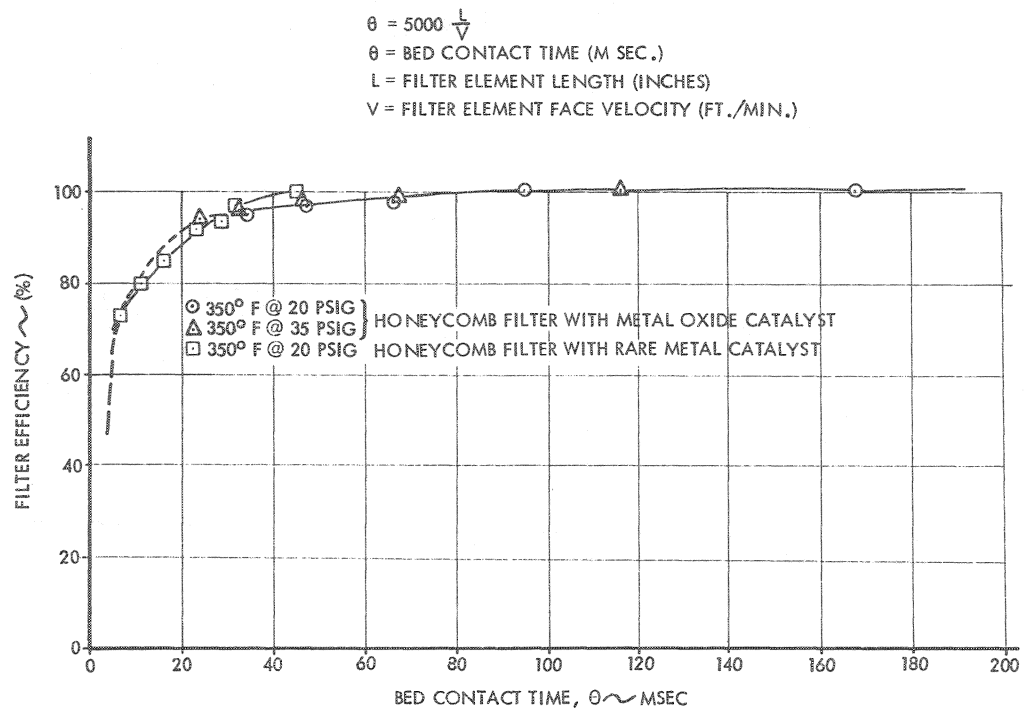


FIG. 41. EFFECT OF FUEL CONTAMINATION ON OZONE FILTER EFFICIENCY - RARE METAL HONEYCOMB FILTER UNIT

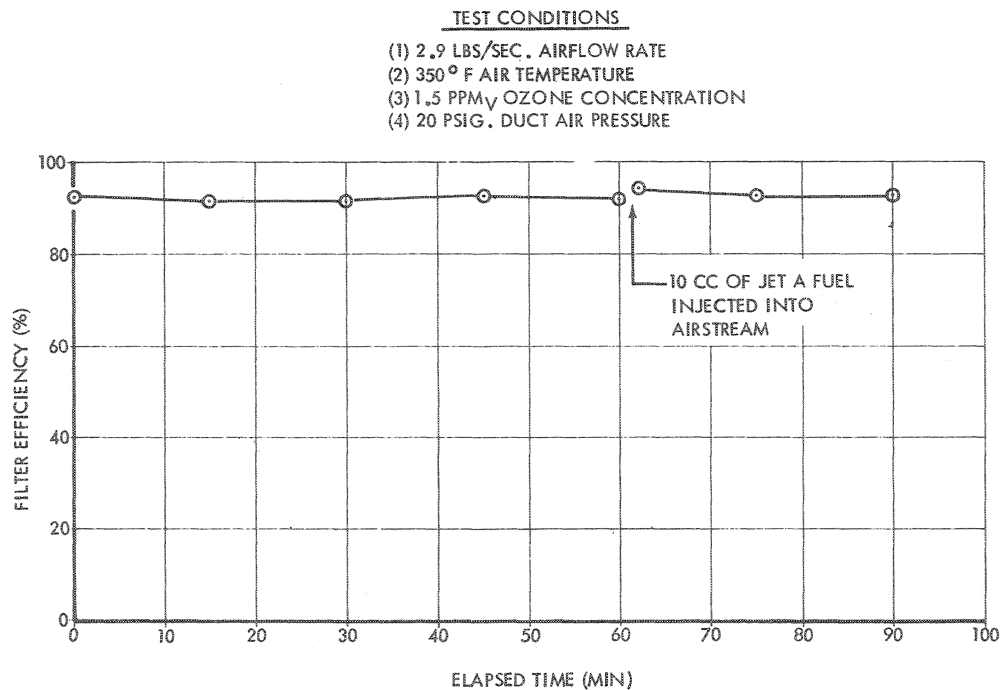




FIG. 42. RARE METAL HONEYCOMB OZONE FILTER LIFE CYCLE TEST

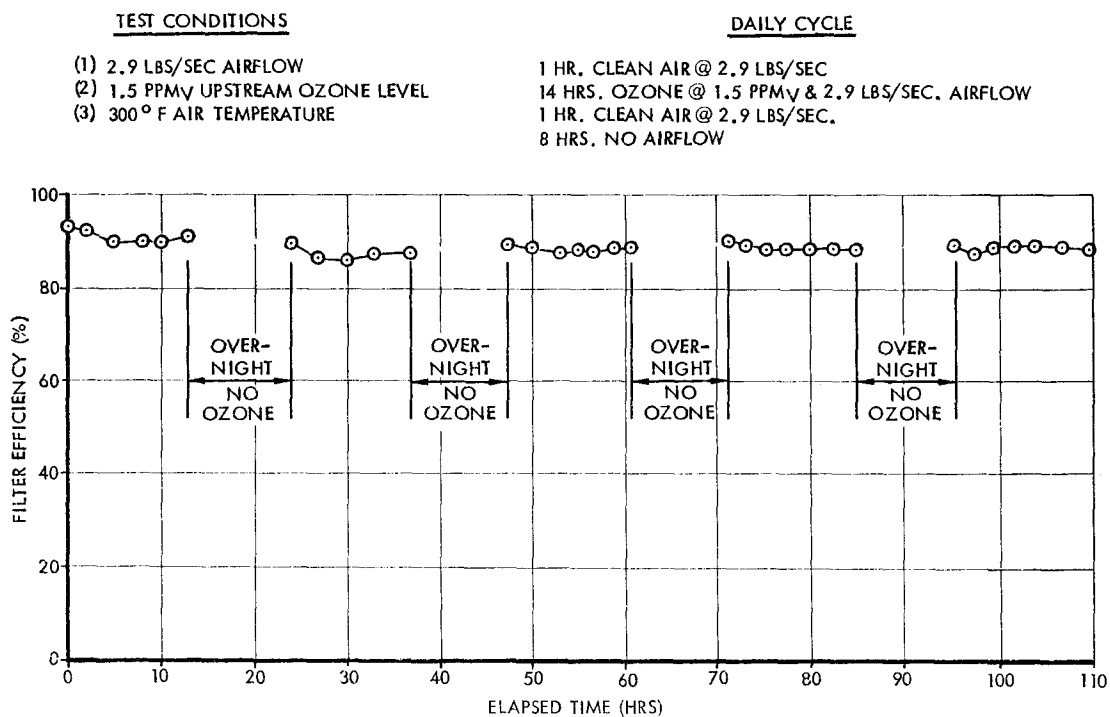


FIG. 43. METAL OXIDE HONEYCOMB OZONE FILTER LIFE CYCLE TEST

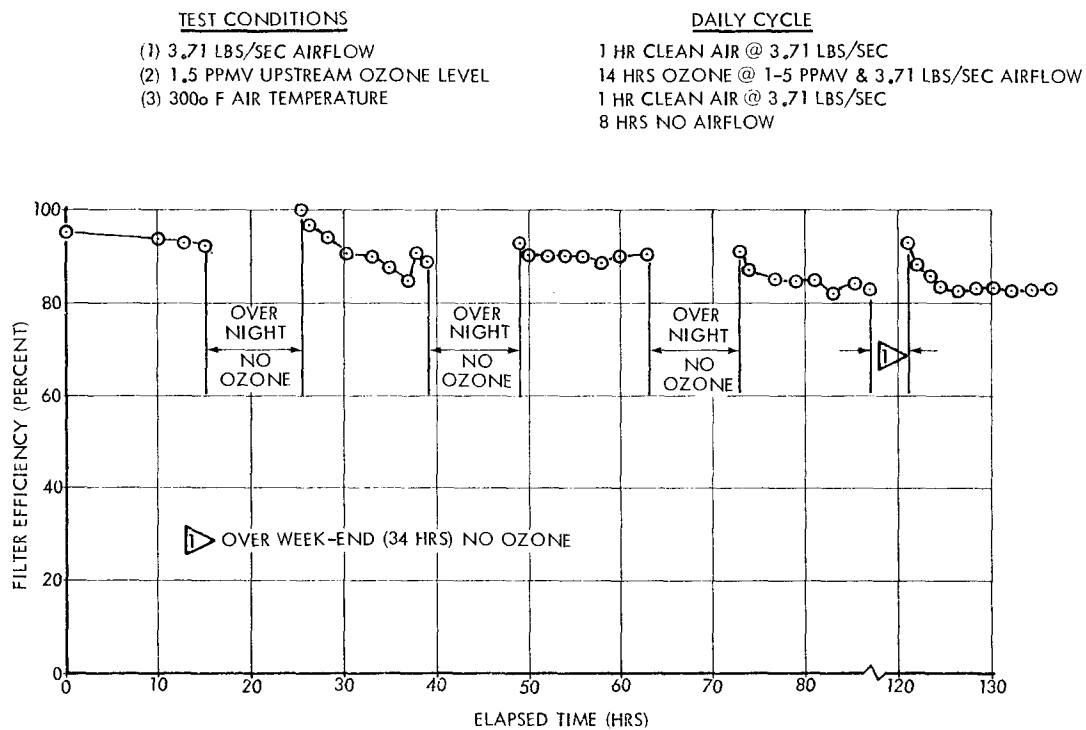


FIG. 44. EFFECT OF TIME & OZONE LEVEL ON METAL OXIDE TYPE FILTER CATALYST ELEMENT PERFORMANCE

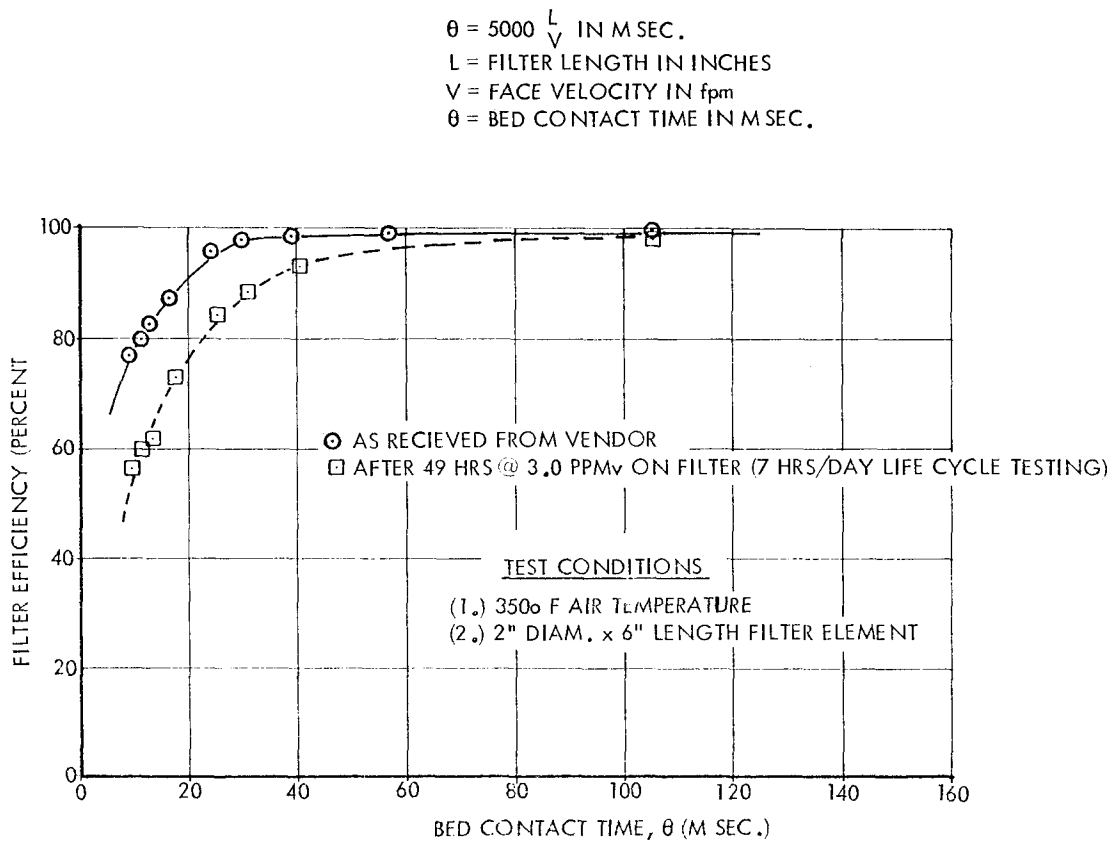


FIG. 45. FUTURE OZONE FILTER DEVELOPMENT PROGRAM

● MATERIAL TESTS

- EVALUATE NEW MATERIALS
- IMPROVE EFFICIENCY
- REDUCE WEIGHT
- ESTABLISH FILTER LIFE

● PRODUCTION FILTER

- REQUEST PROPOSALS
- PROCURE PROTOTYPE UNIT FOR LAB & SERVICE TESTS
- FINAL PRODUCTION DESIGN & PROCUREMENT